UNIVERSITY OF CALIFORNIA PUBLICATIONS

IN

ZOÖLOGY

VOLUME XLVIII

1942–1949

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1949

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

ERRATA

In No. 6, pp. 377–526, "Speciation in Salamanders of the Plethodontid Genus *Ensatina*," by Robert C. Stebbins, last line of Acknowledgments, for Ian T. McCowan, read Ian McT. Cowan; and for *croceator* read *croceater*, throughout.

MAMMALS OF THE BIG BEND AREA OF TEXAS

BY

ADREY E. BORELL AND MONROE D. BRYANT

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1942

University of California Publications in Zoölogy

Volume 48, No. 1, pp. 1–62, plates 1–5, 1 figure in text
Submitted by editors December 7, 1940
Issued August 7, 1942
Price, 75 cents

University of California Press
Berkeley, California

Cambridge University Press
London, England

Printed in the United States of America

CONTENTS

MAMMALS OF THE BIG BEND AREA OF TEXAS

BY

ADREY E. BORELL AND MONROE D. BRYANT

(A Contribution from the National Park Service and the Museum of Vertebrate Zoölogy of the University of California)

INTRODUCTION

WITH THE PROPOSAL to create a national park in the Big Bend area in the southern part of Brewster County, Texas, came the demand for more information concerning the biology of the area. The proposed park, as of January, 1938, forms a rough triangle extending along the Rio Grande from Lajitas on the west to the mouth of Boquillas Canyon on the east, and north to Persimmon Gap. It includes approximately 780,000 acres or 1218.75 square miles (fig. 1). The mammals of this restricted area comprise the subject matter of our study.

Several parties have done field work in the Big Bend area. In 1901 employees of the United States Bureau of Biological Survey worked briefly at Boquillas and Bone Spring, in the Chisos Mountains, and at other locations (Bailey, 1905). Collections of mammals were made by Maynard S. Johnson of the National Park Service in the autumn of 1935; by a party under the direction of Karl P. Schmidt of the Field Museum of Natural History, which collected in the Chisos Mountains in July, 1937; and by the University of Michigan Museum of Zoölogy. Tarleton F. Smith, working under the auspices of the National Park Service, recorded observations on the larger mammals in the summers of 1936 and 1937.

Field studies were made by Borell from July 15–July 18, and October 16–December 3, 1936; March 20–April 20, April 30–May 9, and October 6–October 30, 1937. Camps were situated in the following places: The Basin (October 20–November 6, November 9–17, November 23–29, 1936; April 3–5, October 7–9, October 30, 1937); Boquillas (November 7–8, 1936); Nail Ranch (March 23–April 2, April 6–11, May 3, 1937); Johnson Ranch (April 12–20, 1937); Lajitas (May 1–2, 1937); mouth of Santa Helena Canyon (November 18–19, 1936); Smoky Spring (November 20–22, 1936); northeast base of Mesa de Anguila (November 30–December 1, 1936); Pine Canyon (May 4–9, 1937); Glenn Spring (October 10–22, 1937); Daniel Ranch (October 23–29, 1937).

We are especially indebted to Dr. E. Raymond Hall for critical assistance in the preparation of our manuscript at the Museum of Vertebrate Zoölogy of the University of California. For the loan of essential specimens and other materials we thank Dr. William H. Burt and Dr. W. Frank Blair of the Museum of Zoölogy of the University of Michigan, Karl P. Schmidt of the Field Museum of Natural History, Dr. J. Eric Hill of the American Museum of Natural History, Drs. Maynard S. Johnson, W. B. McDougall and Tarleton

F. Smith, all of the National Park Service, and Dr. O. E. Sperry of Sul Ross State Teachers College. To single out names of friends living in the Big Bend area who contributed specimens or otherwise aided in the field work would be invidious. The names of most of these are recorded in the accounts of species and the names of all are recorded in the authors' grateful remembrance of their assistance.

This paper is a joint contribution of the National Park Service and the University of California Museum of Vertebrate Zoölogy. Adrey E. Borell, representing the National Park Service, did the field work and prepared the remarks concerning information obtained in the field. Monroe D. Bryant, representing the Museum, identified the specimens, prepared the taxonomic accounts and put the manuscript in final form.

PHYSICAL CHARACTER OF THE AREA

The Big Bend area is an arid, semidesert plain on which there are mountains and mesas. In elevation it extends from 1700 feet, just below the mouth of Boquillas Canyon, to 7835 feet, at the top of Emory Peak. The annual rainfall varies from about eight inches, in the flats which surround the mountains and mesas, to possibly fifteen inches in the higher parts of the Chisos Mountains. These mountains comprise the outstanding physical feature of the area. They are extremely rugged and are encircled by sharply sloping foothills, which merge with the plain. The mountains and foothills are watered by springs. The plain is deeply cut by arroyos which have resulted from the rapid run-off of water from the mountains following the heavy intermittent summer storms.

ASSOCIATIONS

There are four distinct associations of plant and animal life, which may be described briefly as follows:

River Bottom (pl. 1).—The entire river bottom presents a type of habitat not found in other parts of the area. Most of the river bottom is narrow, but in a few places it is one-half mile or more in width. Here, in sand, silt, and gravel, the dominant plants are mesquite (*Prosopis*), cane (*Phragmites communis*), false willow (*Baccharis*), cottonwood (*Populus*), willow (*Salix*), and wild grape (*Vitis*).

Mammals found only in this association were *Cratogeomys castanops lacrimalis, Dipodomys ordii attenuatus, Castor canadensis mexicanus,* and *Sigmodon hispidus berlandieri.*

Santa Helena (pl. 1, *b*), Mariscal, and Boquillas canyons are so narrow and precipitous that little space is available for plants and animals.

Desert Flat (pls. 2; 4, *a*).—The terrain referred to as flats is actually rather rough. It is cut by many arroyos and washes and is rocky, except in the washes and in a few sandy areas. Large portions of it support but scant vegetation and few animals. Rainfall is light and springs are scarce. This association extends roughly from 2000 to 3500 feet elevation.

The dominant vegetation consists of ocotillo (*Fouquieria*), cholla, prickly pear, other cacti, and creosote bush (*Larrea*). Desert willow (*Chilopsis*),

mesquite (*Prosopis*), catclaw (*Acacia*), and lignum vitae (*Porliera*) grow along the washes.

Citellus spilosoma major and *Perognathus merriami gilvus* appeared to be confined to this association.

Lower Foothill (pl. 5, *b*).—An area between 3500 and 4500 feet elevation about the base of the Chisos Mountains presents a distinct association. The only good growth of grama and other palatable grasses is found here on the mesas and slopes. The dominant plants are sotol (*Dasylirion*), bear grass (*Nolina*), lecheguilla (*Agave lecheguilla*), grama (*Bouteloua*), and other grasses. Oak (*Quercus*), black persimmon (*Diospyros*) and catclaw (*Acacia*) are found in the canyons.

The main range of *Odocoileus hemionus crooki* and *Reithrodontomys fulvescens canus* is in this association.

Parts of the Dead Horse Mountains, Mariscal Mountain, Mesa de Anguila, Grapevine Hills, and other hills and mesas present conditions characteristic of this association. There are more springs than in any other association, but here the watering places are widely separated.

Chisos Mountains proper (pls. 3; 4, *b*; 5, *a*).—This association extends upward from 4500 feet. Piñon (*Pinus cembroides*), juniper (*Juniperus*, 3 species), oak (*Quercus*, several species), black persimmon (*Diospyros*), and many kinds of shrubs cover the walls of the canyons and steep mountainsides. In a few limited areas yellow pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga taxifolia*), and madroña (*Arbutus*) indicate spots of the Transition life zone.

Odocoileus virginianus carminis, Ursus americanus amblyceps, Sigmodon ochrognathus, Sylvilagus robustus, Peromyscus boylii rowleyi, and *Peromyscus pectoralis laceianus* are mainly or entirely confined to this association.

PLACE NAMES

A list of the names of places mentioned in the present paper is given below. The exact position of each place may be determined by referring to figure 1. The topographic map referred to is the Chisos Mountains quadrangle, edition of 1905, of the United States Geological Survey topographic map.

BASIN [THE] (pl. 3, *b*), 5000–5660 feet, head of Oak Creek. Called "Green Gulch" on topographic map, National Park Service headquarters.

BIG BEND OF RIO GRANDE, 2000 feet. Same as Johnson Ranch.

BLUE CREEK, southwest slope of Chisos Mountains.

BONE SPRING, 2678 feet, 4 miles south of Persimmon Gap.

BOQUILLAS, 1800 feet, village on Rio Grande at the head of Boquillas Canyon. The present Boquillas is about 7½ miles southeast of the point marked "Boquillas" on the topographic map.

BOQUILLAS CANYON, on Rio Grande in southeast part of proposed park area.

BURNHAM RANCH, 3960 feet, north base of Chisos Mountains. This is Waddy T. Burnham's ranch and is situated at Government Spring.

BURRO MESA, up to 4400 feet, west base of Chisos Mountains.

CASTOLON, 2100 feet, village on Rio Grande; also spelled "Castelan," "Castellan," and "Castalon." It is southwest of Cerro Castellan, which is shown on the topographic map.

CHILICOTAL MOUNTAIN, 4104 feet, east base of Chisos Mountains.

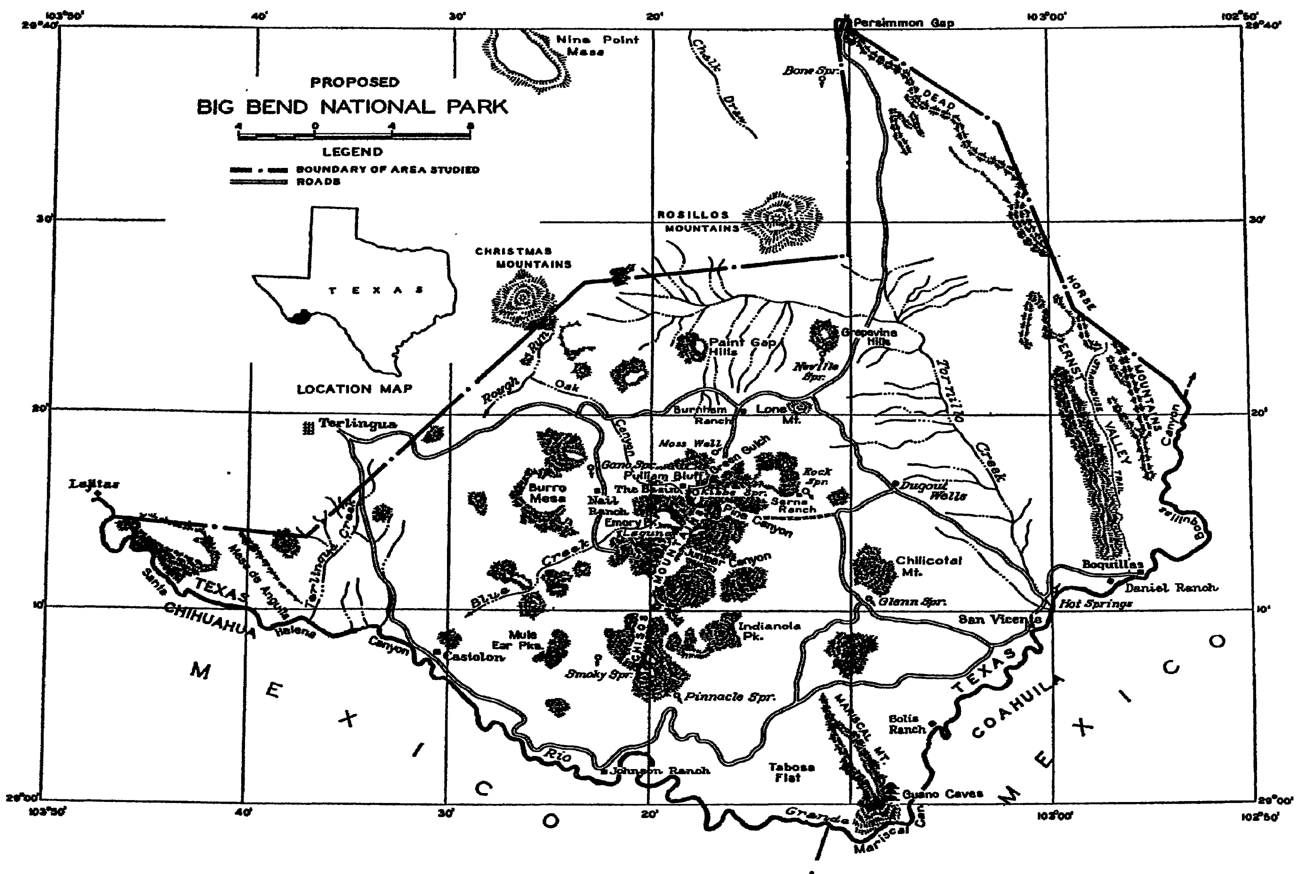


Fig. 1. Map of the Big Bend area proposed as a national park, as of January, 1938, showing place names referred to in the text

CHISOS MOUNTAINS, up to 7835 feet. Largest range in the area.
CHRISTMAS MOUNTAINS, 5735 feet, northwest of Chisos Mountains.
CHALK DRAW, southwest of Persimmon Gap.
DANIEL RANCH, 1850 feet. John Daniel's ranch on Rio Grande, one mile southwest of Boquillas; formerly known as Graham Ranch.
DEAD HORSE MOUNTAINS, up to 5857 feet, local name for Sierra del Caballo Muerto, along eastern boundary of proposed park area.
DUGOUT WELLS, 2940 feet, on flat east of Chisos Mountains; locally called "Dugout."
EMORY PEAK (pl. 4, *b*), 7835 feet. Highest peak in the Chisos Mountains.
GANO SPRING, 3400 feet, north base of Burro Mesa.
GLENN SPRING, 2606 feet, southeast base of Chisos Mountains.
GOVERNMENT SPRING, the spring at Waddy T. Burnham's ranch house.
GRAHAM RANCH, same as Daniel Ranch.
GRAPEVINE HILLS, up to 3859 feet, north of Chisos Mountains.
GREEN GULCH, 4800–6100 feet, on north side of Chisos Mountains. It is the canyon through which the new road passes. This is not the area shown as "Green Gulch" on the topographic map.
GUANO CAVES, southeast slope of Mariscal Mountain.
HOT SPRINGS, 1900 feet, on Rio Grande at mouth of Tornillo Creek. Not shown on topographic map.
INDIANOLA PEAK, 5240 feet, southeast base of Chisos Mountains.
JOHNSON RANCH, 2060 feet, Elmo Johnson's ranch on Rio Grande. Not shown on topographic map; south and slightly west of Reed Camp.
JUNIPER CANYON, 4000–6000 feet, on east slope of Chisos Mountains.
KIBBE SPRING, 5700 feet, on the slope of Casa Grande at eastern end of the Basin. Not shown on topographic map.
LAGUNA (pl. 4, *b*), 6500 feet, west base of Emory Peak; also called Laguna Meadow.
LAJITAS, 2400 feet, village on Rio Grande at northwest end of Mesa de Anguila.
LONE MOUNTAIN, 4132 feet, near northeast base of Chisos Mountains.
MARISCAL CANYON, on Rio Grande south of Mariscal Mountain.
MARISCAL MOUNTAIN, 2400–3940 feet, southeast of Chisos Mountains.
MESA DE ANGUILA, up to 3884 feet, north of Santa Helena Canyon.
MOSS WELL, 4700 feet, in Green Gulch.
MULE EAR PEAKS (pl. 2, *b*), 3880 feet, southwest base of Chisos Mountains.
NAIL RANCH, 3500 feet, Sam Nail's ranch at east base of Burro Mesa.
NEVILLE SPRING, 3293 feet, about 2 miles south of Grapevine Hills.
NINE POINT MESA, 3500–5551 feet, 17 miles west of Persimmon Gap.
OAK CANYON, 4000–5000 feet, northwest slope of Chisos Mountains, heads in the Basin.
OAK CREEK, in Oak Canyon.
PAINT GAP HILLS, up to 4258 feet, northwest of Government Spring.
PERSIMMON GAP, northernmost point of proposed national park.
PINE CANYON (pl. 5), 4000–6000 feet, on northeast slope of Chisos Mountains; sometimes called Wade Canyon.
PINNACLE SPRING, 2800 feet, south base of Chisos Mountains, 4 miles north and slightly east of Reed Camp. Shown on topographic map but not named.
PULLIAM BLUFF (pl. 3, *b*), 6921 feet, northwest part of Chisos Mountains.
ROCK SPRING, 3900 feet, at mouth of Pine Canyon on R. A. Serna's ranch.
ROSILLOS MOUNTAINS, up to 5420 feet, north of Chisos Mountains.
ROUGH RUN, 2500–3500 feet, north of Burro Mesa; empties into Terlingua Creek.
SAN VICENTE, 1880 feet, village on Rio Grande east of Chisos Mountains.
SERNA RANCH, R. A. Serna's ranch at mouth of Pine Canyon.
SIERRA DEL CABALLO MUERTO, same as Dead Horse Mountains.
SMOKY SPRING, 3800 feet, south slope of Chisos Mountains, about 2 miles east of Mule Ear Peaks.
SOLIS RANCH, 1919 feet, on the Rio Grande southeast of Chisos Mountains.

STRAWHOUSE TRAIL, a trail leading from Boquillas north through Ernst Valley into the Dead Horse Mountains.

TABOSA FLAT, 2000–3000 feet, large flat west of and adjoining Mariscal Mountain.

TERLINGUA, village, about 17 miles west of the Chisos Mountains.

TERLINGUA CREEK, southwest of Chisos Mountains.

TORNILLO CREEK, east of Chisos Mountains.

UPPER JUNIPER SPRING, 5000 feet, in Juniper Canyon on east slope of Chisos Mountains.

ACCOUNTS OF SPECIES

Access to the facilities of the Museum of Vertebrate Zoölogy of the University of California has enabled us to study geographic variation in the species of mammals occurring in the Big Bend area. The results of this study and the information secured by observations in the field are included in the accounts of the species. The capitalized color terms are according to the plates in Ridgway's "Color Standards and Color Nomenclature" (Washington, D. C., 1912). Unless otherwise indicated, all of the measurements are in millimeters and are of adult specimens.

Didelphis mesamericana texensis Allen

Mexican Opossum

Didelphis marsupialis texensis Allen, Bull. Amer. Mus. Nat. Hist., 14:172, June 15, 1901.
Didelphis mes-americana texensis Allen, Bull. Amer. Mus. Nat. Hist., 16:256, August 18, 1902.

Remarks.—Our only records of the Mexican opossum are of a few animals taken by trappers. Lloyd Wade reported that one was trapped in the Rosillos Mountains about 1930 and that he saw the skin of another which was trapped at the mouth of Pine Canyon in the winter of 1936–37. W. L. Hannold, who operates a trading post on Tornillo Creek, stated that he bought the skins of two opossums which had been trapped near Pinnacle Spring in the winter of 1930–31. The capture of an opossum is so unusual that several ranchers independently reported to us that one was trapped in Pine Canyon about 1921 by Harry White of Marathon.

Probably the opossums in Brewster County are referable to *D. m. texensis* rather than to *D. virginiana* and have reached this area by following along the Rio Grande. This assumption is based on the known distribution of these forms. The few opossums found here appear to be native, since none of the residents interviewed knew of any having been introduced.

Notiosorex crawfordi crawfordi (Coues)

Crawford Shrew

Sorex (Notiosorex) crawfordi Coues, Bull. U. S. Geol. and Geogr. Surv. Terr., 3:651, May 15, 1877.
Notiosorex crawfordi, Dobson, Mon. Insectivora, pt. 3: pl. 23, fig. 20, 1890.

Specimen examined.—One adult female, no. 80281, from E base of Burro Mesa, 3500 feet.

Measurements.—Total length, 88; tail vertebrae, 25; hind foot, 10; ear from notch, 6.5; greatest length of skull, 16.3; interorbital breadth, 4.1; width of brain case, 8.0; palatilar length, 7.2; length of upper premolar–molar series, 4.2.

Comparisons.—The upper parts of this specimen are not as brown as those of *N. c. crawfordi,* from San Diego County, California. The specimens are otherwise indistinguishable.

Remarks.—This specimen was trapped at the base of a dry, rocky cliff, about 50 yards from a small seepage. Efforts to trap others at the same site were unsuccessful.

Leptonycteris nivalis (Saussure)

Long-tongued Bat

M.[=*Ischnoglossa*] *nivalis* Saussure, Rev. et mag. de zool., 12:492, November, 1860.
Leptonycteris nivalis, Miller, Proc. Biol. Soc. Wash., 13:126, April 6, 1900.

Specimens examined.—Four: nos. 80326; alcoholic 80327; Field Museum alcoholics 46869, 46874; all from Mount Emory, 7100 feet.

Measurements.—One male and 1 female: total length, 93, 83; foot, 16, 15; ear from notch, 14, 14; tibia, 22.0, 22.5; forearm, 58.1, 58.9; third metacarpal, 54.8, 55.9; fifth metacarpal, 47.0, 47.1; thumb, 8.6, 9.0.

For the opportunity to study these specimens and to examine the manuscript of a forthcoming paper on the genus *Leptonycteris* we are indebted to Colin Campbell Sanborn. This species has not been previously reported in Texas. The specimens were found by Karl Schmidt in a large cave on the west slope of Mount Emory in July, 1937. All are in the brown phase.

Myotis yumanensis yumanensis (H. Allen)

Yuma Myotis

Vespertilio yumanensis H. Allen, Smithsonian Misc. Coll., 165:58, June, 1864.
Myotis yumanensis yumanensis, Miller, Bull. U. S. Nat. Mus., 79:56, December 31, 1912.

Specimens examined.—Four: nos. 80285–80287; Field Museum 46918. These are from the following localities: Kibbe Spring, 5700 feet, 1; 1 mile SW of Boquillas, 1850 feet, 2; mouth of Santa Helena Canyon, 2146 feet, 1.

Measurements.—Two adult males: total length, 76, 81; tail vertebrae, 33, 30; foot, 7, 7; ear from notch dry, 13, 12; tibia, 15.0, 13.6; forearm, 30.9, 31.7; third metacarpal, 29.9, 28.6; fifth metacarpal, 28.0, 27.5; greatest length of skull, 13.3, 13.3; zygomatic breadth, —, 8.1; interorbital constriction, 3.8, 4.0; mastoidal breadth, 7.0, 7.0; occipital depth, 5.0, 5.0; maxillary tooth row including canine, 5.1, 5.1; maxillary breadth at third upper molar, 5.3, 5.2; mandible, 9.6, 9.7; mandibular tooth row including canine, 5.5, 5.4.

Comparisons.—Our specimens fall within the range of individual variation of *M. y. yumanensis,* as known to us by animals from Camp Verde, Yavapai County, Arizona, and also by Miller and Allen's (1928:65) account, but show the following average differences: the upper parts are lighter, the tips of the hairs being Pinkish Buff to Pale Pinkish Buff, and the wing as a whole is smaller as a result of the shortening of the forearm and metacarpals.

Remarks.—The Yuma Myotis was common in the evenings along the Rio Grande, where it came to drink just after sundown. At times fifty or more were seen as they skimmed the water or foraged close to the ground.

Myotis californicus californicus (Audubon and Bachman)

California Myotis

Vespertilio californicus Audubon and Bachman, Jour. Acad. Nat. Sci. Phila., 8:285, 1842.
Myotis californicus californicus, Miller, Bull. U. S. Nat. Mus., 79:56, December 31, 1912.

Specimens examined.—Three: nos. 80282–80284, from E base of Burro Mesa, 3500 feet.

Measurements.—Two adult males: total length, 75, 76; tail vertebrae, 36, 35; foot, 6, 7; ear from notch dry, 13, 12; tibia, 14.9, 14.5; forearm, 33.0, 32.9; third metacarpal, 30.5, 29.9; fifth metacarpal, 29.6, 29.3; greatest length of skull, 13.5, 13.6; zygomatic breadth, 8.4, —; interorbital constriction, 3.3, 3.4; mastoidal breadth, 6.7, 7.0; occipital depth, 4.6, 4.6; maxillary tooth row including canine, 5.1, 5.2; maxillary breadth at third upper molar, 4.9, 5.2; mandible, 9.6, 9.4; mandibular tooth row including canine, 5.4, 5.5.

Comparisons.—The Big Bend specimens are referable to *M. c. californicus*, as known to us by animals from San Diego and Mariposa counties, California. They differ from the California specimens in the lighter color of the upper parts, but are more like *californicus* than like *pallidus* in this respect. *M. c. pallidus* is known to us by topotypes. A ring of lighter color occurs between the Sooty Black base and the Light Ochraceous Tawny tip of the hairs of the back, but it is not clearly defined as in *pallidus*. All measurements agree with those for *californicus*.

Remarks.—Three specimens were taken at a water tank at the east base of Burro Mesa.

Myotis thysanodes thysanodes Miller

Fringe-tailed Myotis

Myotis thysanodes Miller, N. Amer. Fauna, 13:80, October 16, 1897.

Myotis thysanodes thysanodes Miller and Allen, Bull. U. S. Nat. Mus., 144:126, May 25, 1928.

Specimens examined.—Six: nos. 80288–80292; Field Museum 46917. These are from Mount Emory, 7100 feet, 1, and SE slope of Mariscal Mountain, 2800 feet, 5.

Measurements.—One adult male and 1 adult female: total length, 88, 91; tail vertebrae, 34, 33; foot, 9, 10; ear from notch dry, 15, 17; tibia, 17.0, 16.7; forearm, 41.9, 42.6; third metacarpal, 39.0, 40.3; fifth metacarpal, 37.5, 38.0; greatest length of skull, 16.1, 16.7; zygomatic breadth, 10.7, 11.9; interorbital constriction, 4.4, 4.1; mastoidal breadth, 8.1, 8.6; occipital depth, 5.6, 5.8; maxillary tooth row including canine, 6.4, 6.6; maxillary breadth at third upper molar, 6.6, 7.0; mandible, 11.8, 12.1; mandibular tooth row including canine, 6.9, 7.0.

Comparisons.—Compared with specimens of *M. t. thysanodes* taken in July at Tejon Ranch, Kern County, California, the upper parts of specimens taken from the Big Bend area in October are brighter in color, with the tips of the hairs Light Ochraceous Buff. The tail is relatively shorter and the zygomatic breadth greater.

Remarks.—Our records of *M. t. thysanodes* consist of a single male taken on Mount Emory in July and five females found on October 19 in a limestone cave high on the southeast slope of Mariscal Mountain. The cave consists of a small tunnel, about 50 yards long, and two small chambers connected with it. *Corynorhinus rafinesquii pallescens* and *Tadarida mexicana* were found in this cave on the same day. The *Corynorhinus* were near the entrance, the *Tadarida* at the inner end of the cave, and the *Myotis* formed a compact group about 25 yards in from the entrance. One of the fringe-tailed bats was suspended from the ceiling; the others were about 6 inches away crowded into a small pocket 4 inches deep and 1½ inches in diameter. The bats apparently had sought this small retreat as a normal resting place, as they had not previously been disturbed. The group probably would have been overlooked if the

single individual had not been hanging outside the pocket. They did not fly away when a flashlight was turned on them. A complete search of the cave failed to reveal other fringe-tailed bats.

Pipistrellus hesperus maximus Hatfield

Western Pipistrelle

Pipistrellus hesperus maximus Hatfield, Jour. Mammal., 17:261, August 14, 1936.

Records of occurrence.—Specimens examined, 31: nos. 80293–80295, 81681, 81682; skeletons only 80306, 84125, 84126; alcoholics 80296–80305, 80307, 80308; Field Museum 46893–46897, 46900, 46904, 46906–46909. These are distributed by localities as follows: Chisos Mountains, 1; 5 miles S of the Basin, 1; Kibbe Spring, 5700 feet, 9; E base of Burro Mesa, 3500 feet, 17; Boquillas, 1800 feet, 2; Glenn Spring, 2606 feet, 1. Other record of occurrence: Boquillas (Bailey, 1905:210).

Measurements.—Average of 5 adult males: total length, 77 (73–80); tail vertebrae, 31.2 (31–32); foot, 7.0 (6.0–7.5); ear from notch dry, 9.2 (8.6–9.6); tibia, 12.3 (11.9–12.9); forearm, 30.5 (29.9–31.1); fifth metacarpal, 27.4 (26.3–28.5); greatest length of skull, 12.5 (12.1–13.2); zygomatic breadth, 7.8 (7.6–8.0); interorbital constriction, 3.6 (3.5–3.7); greatest breadth of skull above bullae, 6.6 (6.5–6.7); occipital depth, 4.1 (4.0–4.2); maxillary tooth row including canine, 4.5 (4.4–4.6); maxillary breadth at third upper molar, 5.3 (5.1–5.5); mandible, 8.9 (8.7–9.0); mandibular tooth row including canine, 4.5 (4.5–4.6).

Comparisons.—These specimens resemble *P. h. maximus,* as known to us by Hatfield's original description, in the following features: size large, forearm in females more than 31.5 mm., concavity of nasofrontal area, and in other measurements taken. They differ from *maximus* in the more reddish coloration of the upper parts, only four of sixteen specimens being Smoke Gray. They are darker in color than *hesperus,* as known to us by specimens from Nye, Lincoln, and Washoe counties, Nevada, and Yavapai County, Arizona, and lighter than *australis,* from 28 miles north of Cumpas, Sonora, Mexico. Since the only noteworthy difference from *maximus* is the darker coloration, the specimens are referred to that subspecies.

Remarks.—The western pipistrelle is probably the most abundant bat in the area. It ranges from the Rio Grande at least up to 5700 feet in the Chisos Mountains. In 1937 it was common at the Nail Ranch from March 23 to April 11 and on October 8; in Pine Canyon, May 4–10; at Kibbe Spring, on October 6–7; at Glenn Spring, October 11–22; at Boquillas, on October 16; and at the Daniel Ranch, October 24–28. The bats appear just after sundown and tend to congregate about watering places. They can best be taken at this time by stretching wires across a water tank (Borell, 1937:478). Thirty-two specimens were taken by this method at the Nail Ranch in six nights in March and April, and 30 were taken on October 8. Most of these were released.

Eptesicus fuscus pallidus Young

Big Brown Bat

Eptesicus pallidus Young, Proc. Acad. Nat. Sci. Phila., 1908:408, October 2, 1908.
Eptesicus fuscus pallidus, Miller, Bull. U. S. Nat. Mus., 79:62, December 31, 1912.

Records of occurrence.—Specimen examined: one adult female, no. 80309, from E base of Burro Mesa, 3500 feet. Other record of occurrence: Chisos Mountains (Bailey, 1905:211).

Measurements.—Total length, 103; tail vertebrae, 40; foot, 9; ear from notch dry, 17; tibia, 18.0; forearm, 45.1; third metacarpal, 42.6; fifth metacarpal, 40.1; greatest length of skull, 18.7; zygomatic breadth, 12.3; interorbital constriction, 4.3; mastoidal breadth, 9.4; occipital depth, 6.1; maxillary tooth row including canine, 7.3; maxillary breadth at third upper molar, 7.9; mandible, 14.3; mandibular tooth row including canine, 7.9.

Comparisons.—Comparison of this specimen with *E. f. pallidus,* from Julian, San Diego County, California, and with *E. f. fuscus,* from Ardmore, Philadelphia County, Pennsylvania, shows that it is referable to *pallidus.* We agree with the views of Allen (1933) and Engels (1936) concerning the restriction of the name *fuscus* to the darker eastern race, and of *pallidus* to the paler race found from the Mississippi River to the Sierra Nevada–Cascade mountain chain. In the light of our present knowledge it seems that the animals referred to *fuscus* by Bailey (1905 :211) are instead referable to *pallidus.*

Remarks.—A single female was taken on April 11, 1937, at a water tank on the Nail Ranch. Bailey's (*loc. cit.*) report of a male taken at 6000 feet elevation in "the gulch" on June 9 is the only other record in the Big Bend area.

Lasiurus cinereus (Beauvois)

Hoary Bat

Vespertilio cinereus (misspelled *linereus*) Beauvois, Catal. Raisonné Mus. Peale, Phila., p. 18, 1796.

Lasiurus cinereus, H. Allen, Smithson. Misc. Coll., 165 :21, June, 1864.

Specimens examined.—Five: nos. 80310–80312; skeleton only 84127; Univ. Mich. alcoholic 79432; from Big Bend of Rio Grande, 2000 feet.

Measurements.—One adult female: total length, 140; tail vertebrae, 56; foot, 11; ear from notch dry, 14; tibia, 22.1; forearm, 54.3; third metacarpal, 63.6; fifth metacarpal, 48.0; greatest length of skull, 17.2; zygomatic breadth, 13.1; interorbital constriction, 5.2; mastoidal breadth, 10.6; occipital depth, 6.8; maxillary tooth row including canine, 6.3; maxillary breadth at third upper molar, 8.9; mandible, 13.5; mandibular tooth row including canine, 7.0.

Remarks.—Hoary bats were fairly common along the Rio Grande at the Johnson Ranch on April 14–20, 1937. They appeared soon after sunset and foraged among the willow trees at the edge of the river. All the specimens are females, but none contained embryos.

Corynorhinus rafinesquii pallescens Miller

Long-eared Bat

Corynorhinus macrotis pallescens Miller, No. Amer. Fauna, 13:52, October 16, 1897.

Corynorhinus rafinesquii pallescens Miller, Bull. U. S. Nat. Mus., 128:82, April 29, 1924.

Specimens examined.—Five: nos. 80313, 80315; alcoholic 80314; mummy 80759; Field Museum 46915. These are from localities as follows: Kibbe Spring, 5700 feet, 2; W slope of Emory Peak, 7100 feet, 2; SE slope of Mariscal Mountain, 2800 feet, 1.

Measurements.—Two adult females: total length, 100, 88; tail vertebrae, 47, 45; foot, 8, 8; ear from notch dry, 32, 31; forearm, 44.9, 42.6; thumb without claw, 6.5, 7.5; third metacarpal, 39.2, 38.6; fifth metacarpal, 38.9, 38.5; tibia, 20.0, 20.0; greatest length of skull, 15.9, 15.8; condylobasal length, 14.9, 14.7; zygomatic breadth, 8.6, 8.4; interorbital constriction, 3.7, 3.5; greatest breadth of skull above bullae, 8.6, 8.6; occipital depth, 5.9, 5.6; maxillary tooth row including canine, 5.2, 5.2; maxillary breadth at third upper molar, 5.7, 5.6; mandible, 10.5, 10.5; mandibular tooth row including canine, 5.6, 5.6.

Comparisons.—These specimens show no noteworthy differences from *C. r. pallescens,* as known to us by animals from Navajo and Yavapai counties, Arizona, and also by Allen's (1916 :341) account.

Seasonal variation in color of the upper parts is clearly evident, although the changes are not great. Specimens taken in July are Light Pinkish Cinnamon, and specimens taken in October are Pinkish Cinnamon above. The under parts show no seasonal variation. The bases of the hairs are slate gray.

Remarks.—This species was found on four occasions in the fall of 1937. A dead one was picked up in a small cave near Kibbe Spring on October 6. Ten bats were seen and a male and female were obtained on October 9 in a large cave on the west slope of Mount Emory. This is the same cave in which Dr. Karl Schmidt collected *Leptonycteris nivalis.* On October 11 a search of several abandoned cinnabar mines in the north end of Mariscal Mountain revealed two bats in one shaft, and one in another. Three bats were found on October 19 in a cave high on the southeast slope of Mariscal Mountain. Each of the bats was hanging from the ceiling near the entrance to the cave or mine shaft.

Antrozous pallidus pallidus (LeConte)

Pallid Bat

V[espertilio]. pallidus LeConte, Proc. Acad. Nat. Sci. Phila., 1854–1855:437, 1856.
Antrozous pallidus, H. Allen, Smithson. Misc. Coll., 165:68, June, 1864.

Records of occurrence.—Specimens examined, 5: nos. 80316–80318; skeleton only 84128; Field Museum 46914. These are distributed by localities as follows: Kibbe Spring, 5700 feet, 1; E base of Burro Mesa, 3500 feet, 3; Big Bend of Rio Grande, 2000 feet, 1. Other record of occurrence: Boquillas (Bailey, 1905:214).

Measurements.—Two adult males: total length, 105, 110; tail vertebrae, 40, 45; foot, 10, 10; ear from notch dry, 23.0, 22.9; tibia, 19.4, 19.0; forearm, 47.6, 50.2; third metacarpal, 44.0, 47.5; fifth metacarpal, 42.5, 44.4; greatest length of skull, 18.5, 19.2; zygomatic breadth, 11.4, 12.3; interobital constriction, 4.3, 4.2; greatest breadth of skull above bullae, 9.3, 9.5; occipital depth, 6.2, 7.0; maxillary tooth row including canine, 6.8, 6.8; maxillary breadth at third upper molar, 7.4, 7.6; mandible, 12.9, 13.6; mandibular tooth row including canine, 7.4, 7.4.

Comparisons.—These specimens exhibit no differences from *A. p. pallidus,* as known to us by Miller's (1897 :43) account. They have smaller ears than specimens from Oraibai, Navajo County, and Camp Verde, Yavapai County, Arizona.

Remarks.—An adult female was obtained on April 11 and an adult male on April 12, at the Nail Ranch. A specimen flew into the radio station at the Johnson Ranch on April 10 and was captured by E. H. Baker. Bailey (*loc. cit.*) records that a female containing two large embryos was taken at Boquillas on May 11.

Tadarida mexicana (Saussure)

Mexican Free-tailed Bat

Molossus mexicanus Saussure, Rev. et mag. de zoöl., 12:283, July, 1860.
Tadarida mexicana, Miller, Bull. U. S. Nat. Mus., 128:86, April 29, 1924.

Records of occurrence.—Specimens examined, 11: nos. 80320; skin only 80319; alcoholics 80321–80325; Field Museum 46916; Univ. Mich. alcoholics 79437–79439. These specimens

are distributed by localities as follows: 5 miles SE of the Basin, 1; E base of Burro Mesa, 3500 feet, 3; SE slope of Mariscal Mountain, 2800 feet, 4; Big Bend of Rio Grande, 3. Other record of occurrence: Boquillas (Bailey, 1905:215).

Measurements.—One adult female: total length, 97.0; tail vertebrae, 33.0; foot, 9.0; ear from notch dry, 13.6; tibia, 14.1; forearm, 44.1; third metacarpal, 45.4; fifth metacarpal, 28.1; greatest length of skull, 16.6; zygomatic breadth, 10.0; interorbital constriction, 4.0; greatest breadth of skull above bullae, 9.8; occipital depth, 6.2; maxillary tooth row including canine, 6.2; maxillary breadth at third upper molar, 7.1; mandible, 11.8; mandibular tooth row including canine, 6.7.

Comparisons.—This species is remarkably uniform in size, as is shown by comparison of the bats from the Chisos Mountains area with those from San Bernardino, Inyo, and Mariposa counties, California; Sonora, Mexico; Socorro County, New Mexico; and Woods County, Oklahoma. The New Mexico, Oklahoma, and Texas specimens have darker underparts than the animals from farther west.

Remarks.—These bats were abundant along the river and in the foothills. Many came to drink at a water tank on the Nail Ranch every night from March 23 to April 11, 1937. In this period 241 males and females were taken in six nights by stretching wires across the tank. Most of these were released. Free-tailed bats were common also at the Johnson Ranch on April 15, 1937, and a few were seen at Boquillas on October 16, 1937. A colony of approximately 3000 was found on October 19, 1937, in a limestone cave high on the southeast slope of Mariscal Mountain. They hung in two clusters, each composed of both males and females. The cave is known locally as the Guano Cave. Several years ago an effort was made to remove the guano for commercial purposes, but the venture was abandoned after a small amount had been taken out.

Tadarida macrotis (Gray)

Big Free-tailed Bat

Nyctinomus macrotis Gray, Ann. Nat. Hist., 4:5, September, 1839.
Tadarida macrotis, Miller, Bull. U. S. Nat. Mus., 128:86, April 29, 1924.

Records of occurrence.—Specimens examined, 14: nos. 81683; complete skeletons 81684–81686; skeletons without skulls Borell field numbers 5775–5784. All from Pine Canyon, 6200 feet (Borell, 1939:65).

Measurements.—Average and extreme measurements of 10 adult females, as recorded by Borell (1939:67): total length, 133.8 (129.0–138.0); tail, 51.0 (48.0–54.0); foot, 9.2 (9.0–10.0); ear from crown, 25.4 (24.0–26.0); wing spread, 417.0 (407.0–432.0); forearm, 60.7 (58.3–63.4); thumb (dried skins), 7.2 (6.8–8.2); tibia, 17.3 (16.8–18.0); exposed portion of tail, 29.0 (25.0–33.0); greatest length of skull, 23.1 (22.7–23.7); zygomatic breadth, 12.5 (12.3–12.9); interorbital breadth, 4.2 (4.1–4.4); occipital depth, 7.8 (7.6–8.0); breadth of brain case, 10.2 (10.0–10.5); basal length, 20.3 (19.8–20.6); maxillary tooth row, 8.9 (8.7–9.2); breadth at second molars, 7.2 (7.0–7.5); length of mandible, 16.1 (15.8–16.5); mandibular tooth row, 9.5 (9.2–9.9).

Comparisons.—*T. macrotis* may be distinguished from other members of the genus by its large size. It also may be distinguished from *T. mexicana*, the only other free-tailed bat known to occur in the Big Bend region, by the longer exposed part of the tail and by the whitish base of the hair.

Remarks.—A colony of about 150 of these bats was discovered in a crevice on May 7, 1937. The colony was still present on October 19, 1938. The speci-

mens collected on both dates were females; eight of ten taken on May 7 contained one embryo each. This was the first breeding colony of *T. macrotis* discovered in the United States. A large deposit of guano was present at the base of the cliff, which leads us to assume that the colony had occupied this crevice for a number of years. These bats do not leave the roost until after dark, which may account for their rarity in collections.

Ursus americanus amblyceps Baird

Black Bear

Ursus amblyceps Baird, Mamm. N. Amer., pt. 2:29, January, 1859.
Ursus americanus amblyceps, Bailey, No. Amer. Fauna, 25:187, October 24, 1905.

Remarks.—Black bears are fairly common in the higher parts of the Chisos Mountains. Their main range is in the Upper Sonoran and Transition life zones above 5000 feet elevation, but they occasionally range down to 3000 feet. The canyons and slopes above 5000 feet support a good growth of piñon, three species of juniper, several species of oak, black persimmon, yellow pine, madroña, and many kinds of shrubs.

Bears were more numerous in Pine Canyon (pl. 5) than elsewhere in the area. Here the senior author saw several yellow pines which had been deeply scratched by bears. He also saw droppings in Pine Canyon in May and October, 1937; at Laguna (pl. 4, *b*) on November 1, 1936; and at 5000 feet elevation in Juniper Canyon on October 21, 1937. A. Hannold had the skin of a black bear which he had trapped in Blue Creek Canyon in the spring of 1936. Tarleton Smith (MS) saw three adults and two cubs in Pine Canyon in the last week of July, 1936. Bailey (1905:187) states that black bears were common in the upper canyons of the Chisos Mountains in June, 1901. A rider saw two adults at about 5000 feet elevation in Juniper Canyon in June, 1937. Bears are occasionally reported on Mesa de Anguila, the Dead Horse Mountains, and the lower slopes of the Chisos Mountains. Macario Hinojos stated that he captured two small cubs on the western end of Mesa de Anguila in 1901.

Texas game laws now give complete protection to bears in this area. A few are killed because of their interference with the raising of sheep and goats. Heavy grazing by domestic stock probably has reduced the bear's food supply and protective cover.

Procyon lotor mexicanus Baird

Raccoon

Procyon hernandezii var. *mexicana* Baird, Mamm. N. Amer., pt. 2:22, January, 1859.
Procyon lotor mexicanus, Mearns, Proc. Biol. Soc. Wash., 27:65, March 20, 1914.

Remarks.—A few raccoons are present along the Rio Grande. Occasionally one moves away from the river, usually along Terlingua and Tornillo creeks. Fresh tracks were observed at the northeast base of Mesa de Anguila on December 1, 1936; at the Johnson Ranch on April 19, 1936; and at several places along the Rio Grande above Boquillas between October 24 and 28, 1937. Sam Nail said that one was trapped near his house in 1935.

Since no raccoons have been collected in the Big Bend area, the systematic

position of the animals reported there is uncertain. We are referring them to *P. l. mexicanus* on the basis of the known distribution of this race. They may be referable instead to *P. l. fuscipes*.

Bassariscus astutus flavus Rhoads

Ringtail

Bassariscus astutus flavus Rhoads, Proc. Acad. Nat. Sci. Phila., 1893: 417, January 30, 1894.

Records of occurrence.—Specimens examined, 7: nos. 74333, 74334, 80328–80331; Field Museum 46946. These are distributed by localities as follows: The Basin, 5100 feet, 1; Oak Creek, 5400 feet, 4; 1 mile SW of Boquillas, 2. Other record of occurrence: Boquillas (Bailey, 1905:183).

Measurements.—One adult male and one adult female: total length, 770, 720; tail vertebrae, 352, 350; hind foot, 72, 70; ear from crown, 44, 42; occipitonasal length, 78.4, 74.7; zygomatic breadth, 51.5, 49.0; interorbital constriction, 17.4, 17.9; mastoidal breadth, 35.2, 34.7; shelf of bony palate, 29.0, 28.2; greatest length of auditory bulla, 13.0, 13.2; length of first lower molar, 7.9, 7.3; length of talonid of first lower molar, 2.7, 2.4; length of trigonid of first lower molar, 5.2, 4.9; length of second lower molar, 5.5, 4.9; width of second lower molar, 3.0, 2.4. (Measurements of molar teeth as given by Hall, 1927:445.)

Comparisons.—These specimens closely resemble *B. a. flavus*, as known to us by specimens from Dona Ana County, New Mexico. They have longer tails and the hairs at the anterior border of each black ring of the tail are Ochraceous Buff. The pelage of specimens taken in February is more dense and darker dorsally than in specimens taken in October. The upper parts of immature animals are grayish.

Remarks.—The ringtail is the most abundant fur bearer in the Big Bend area. It is common from the river bottom to at least 5500 feet elevation in the Chisos Mountains, and some signs were observed above Laguna at 6700 feet. Nine ringtails were taken in Oak Canyon from October 24 to October 29, 1936. Signs were abundant about the black persimmon trees, and the droppings of ringtails, gray foxes, and skunks were composed almost entirely of persimmon seeds. It is significant that small rodents were scarce in this canyon. In addition to the specimens examined, one ringtail was taken in Green Gulch on November 12, 1936; two in Pine Canyon on May 5 and 7, 1937; one near the north end of Mariscal Mountain on October 12, 1937; and one on the bank of the Rio Grande at the mouth of Mariscal Canyon on October 27, 1937. The latter, after it was caught in a trap, was killed by some larger carnivore. The one taken in Pine Canyon on May 5 contained three small embryos. An adult male taken on Oak Creek was fat and weighed four pounds.

Spilogale leucoparia Merriam

Spotted Skunk

Spilogale leucoparia Merriam, N. Amer. Fauna, 4:11, October 8, 1890.

Specimen examined.—One subadult female, no. 80332, from 1 mile SW of Boquillas, 1850 feet.

Measurements.—Total length, 345; tail vertebrae, 138; hind foot, 39; occipitonasal length, 43.9; basilar length, 42.1; zygomatic breadth, 30.5; mastoidal breadth, 26.8; interorbital constriction, 13.5; shelf of bony palate, 14.2; postpalatal length, 23.9; foramen magnum to plane of last molors, 24.5.

Comparisons.—This specimen has a longer tail than *S. leucoparia*, as known to us by animals from Little Box, Chihuahua, Mexico, and 15 miles west of Three Rivers, Otero County, New Mexico, but otherwise shows no essential differences.

Remarks.—Residents reported the spotted skunk from various localities between the Rio Grande and the highest parts of the Chisos Mountains. It is apparently rare, as trapping in many localities resulted in the capture of only one. It was taken on October 26, 1937, on the bank of the Rio Grande. At this point the base of a high rocky cliff is about 30 feet from the edge of the river.

Mephitis mephitis varians Gray

Striped Skunk

Mephitis varians Gray, Charlesworth's Mag. Nat. Hist., 1:581, 1837.
Mephitis mephitis varians, Hall, Carnegie Inst. Wash., 473:66, November 20, 1936.

Records of occurrence.—Specimens examined, 8: nos. 80333–80335; Field Museum 56947–46951. These are distributed by localities as follows: Chisos Mountains, 2; The Basin, 1; Kibbe Spring, 5700 feet, 1; Laguna Meadow, 6500 feet, 1; Oak Creek, 4800 and 5400 feet, 3. Other record of occurrence: Chisos Mountains (Howell, 1901:32).

Comparisons.—These specimens vary greatly in color. The white stripe on the nose may or may not be continuous with the two white stripes on the back. The latter are always broad and enclose a black stripe which may extend from the shoulders to the tail, or may be shorter. The upper surface of the tail varies from black to white, with a scattering of black hairs; the under surface is always more white than black; and a white pencil is at the tip of the tail in five specimens. A white breast patch is present. The animals are distinctly more white than black.

Features of agreement with *M. m. estor*, as known to us by animals from Dona Ana County, New Mexico; Navajo and Cochise counties, Arizona; and Chemehuevis Valley, California, are as follows: dorsal white stripes broad with consequent restriction of enclosed black stripe; tail predominantly white with a pencil at the tip; length of tail less than the length of body. These are also features of difference from *M. m. varians*, as known to us by specimens from Watonga, Oklahoma, and 10 miles east of Roswell, New Mexico. The Chisos Mountains specimens have small, rounded bullae like *varians*. They differ from both *varians* and *estor* in having narrower and relatively longer paroccipital and mastoidal processes, with a deeply concave area between the two.

The distribution of *varians* and *estor* is uncertain. There are reports of intergradation at points as far apart as Mason, Texas (Howell, 1901:32), and the Gila National Forest, New Mexico (Bailey, 1931:332), a distance of approximately 500 miles. A comprehensive study of the animals in this region is desirable, but the material at hand does not permit it. In view of our present knowledge it seems advisable to refer the specimens to *M. m. varians*, although they show rather extensive variations from typical specimens.

Remarks.—According to reports of residents, striped skunks occur from the river bottom to the higher part of the Chisos Mountains. The results of trapping

indicated that they were not numerous in any part of the area and that they were more common in the Chisos Mountains than on the flats or in the river bottom. A subadult female taken in Green Gulch on November 20, 1936, at an elevation of 5000 feet, was released. Trapping along the Rio Grande and about Mariscal Mountain, Burro Mesa, and Glenn Spring was unsuccessful.

Conepatus mesoleucus mearnsi Merriam
Hog-nosed Skunk

Conepatus mesoleucus mearnsi Merriam, Proc. Biol. Soc. Wash., 15:163, August 6, 1902.

Records of occurrence.—Specimens examined, 3: nos. 80336; skull only 74335; Field Museum 46952. These are distributed by localities as follows: The Basin, 5100 feet, 1; E base of Burro Mesa, 3500 feet, 1; Smoky Spring, 3600 feet, 1. Other records of occurrence: Boquillas (Merriam, 1902:163; Bailey, 1905:203).

Measurements.—One adult male: total length, 680; tail vertebrae, 250; hind foot, 73; greatest length of skull, 79.5; condylobasal length, 71.0; palatal length, 29.4; zygomatic breadth, 45.6; interorbital constriction, 19.9; mastoidal breadth, 40.7; width of pterygoid fossa, 7.2; length of pterygoid fossa, 12.0; greatest length of second upper premolar, 7.3; length of first upper molar across metacone and paracone, 8.4; greatest width of first upper molar at cingulum, 8.4.

Comparisons.—In both external and skeletal features the Big Bend specimens closely resemble *C. m. mearnsi* from the Organ Mountains, Dona Ana County, New Mexico, and the Chiricahua Mountains, Cochise County, Arizona. A specimen taken in August is in worn pelage; an April individual is in full winter pelage.

Remarks.—Hog-nosed skunks are common from the river bottom up to 5700 feet elevation in the Chisos Mountains. In many places their presence was indicated by turned-up soil or small excavations about the bases of trees, agave, and sotol. Their diggings were occasionally found in grassy areas and along the banks of the Rio Grande.

In addition to the specimens collected, hog-nosed skunks were seen above the Basin (5700 feet) on November 2 and April 9, 1937; in the Basin (5100 feet) on the night of April 9, 1937; and on the Rio Grande (1850 feet) on October 26, 1937. All the animals seen above 5000 feet elevation were among piñon, juniper, and oaks of several species. Records from all elevations were within one-half mile of permanent water.

Taxidea taxus berlandieri Baird
Badger

Taxidea berlandieri Baird, Pac. R. R. Rept., Mamm., 8:205, 1857.
Taxidea taxus berlandieri, Allen, Bull. Amer. Mus. Nat. Hist., 7:256, June 29, 1895.

Remarks.—Badgers are widely distributed but are not common in the Big Bend area. Ranchers reported them from several localities but most of the diggings observed were on the flats and the lower slopes of the Chisos Mountains.

Urocyon cinereoargenteus scottii Mearns
Gray Fox

Urocyon virginianus scottii Mearns, Bull. Amer. Mus. Nat. Hist., 3:236, June 5, 1891.
Urocyon cinereo-argenteus scottii, Allen, Bull. Amer. Mus. Nat. Hist., 7:253, June 29, 1895.

Records of occurrence.—Specimens examined, 2 females: nos. 80337 and 80338, from Oak Creek, 5400 feet, and Green Gulch, 5200 feet. Other records of occurrence: Chisos Mountains and Boquillas (Bailey, 1905:181).

Measurements.—One adult female: total length, 1050; tail vertebrae, 460; hind foot, 145; ear from crown, 78; occipitobasal length, 113.2; basilar length, 110.4; length of nasals, 38.0; zygomatic breadth, 63.4; palatal length, 56.7; mastoidal breadth, 37.8; greatest length of upper carnassial at cingulum, 10.3; greatest length of first upper molar, 8.8; greatest width of first upper molar, 10.6.

Remarks.—The gray fox is not plentiful in the area. It occurs from the Rio Grande up to at least 5500 feet elevation. Ranchers and trappers reported gray foxes from many localities and habitats. Black persimmon is abundant and in the fruiting season the droppings of gray foxes, as well as those of other carnivores, were composed almost entirely of the large seeds of this plant.

Canis latrans texensis Bailey

Coyote

Canis nebracensis texensis Bailey, N. Amer. Fauna, 25:175, October 24, 1905.
Canis latrans texensis, Nelson, Proc. Biol. Soc. Wash., 45:224, November 26, 1932.

Specimen examined.—One adult male, skull only no. 84137 from E base of Burro Mesa, 3500 feet.

Measurements.—Adult male: basal length of skull, 170.0; basilar length, 166.0; zygomatic breadth, 93.0; palatal length, 89.5; mastoidal breadth, 57.9; paroccipital breadth, 43.2; interorbital constriction, 32.9; length of crown of upper carnassial, 18.2.

Comparisons.—This specimen agrees in all essential features with eight skulls from 20 miles east of Marathon, Brewster County, Texas, and with those from 35 miles east of Las Cruces, Dona Ana County, and from near Artesia, Eddy County, New Mexico, and also with Bailey's (1905:175) description.

The present study involved a comparison of *texensis, mearnsi,* and *nebracensis* that clarifies to some extent the relationship and distribution of these subspecies. The specimens from Brewster County differ from typical *mearnsi,* as known to us by skulls from Quitobaquita and Bates Well, Pima County, Arizona, as follows: size larger; incisive foramina longer, extending back of the plane of the posterior margins of canines; first upper premolar smaller; bullae shorter, deeper and less rounded; paroccipital processes smaller and with more limited contact with posterior part of bullae. Skulls from Tinajas de los Papagos, Sonora, Mexico, are referable to *mearnsi.* Skulls from the southeast corner of Cochise County and from Greenlee County, Arizona, are as large as *texensis* and the incisive foramina show all gradations between *mearnsi* and *texensis*. They agree with *mearnsi* in all other features mentioned. Skulls from Strauss, Dona Ana County, New Mexico, have small incisive foramina like *mearnsi* but otherwise resemble *texensis.*

Comparison of the Brewster County skulls with those of *nebracensis* from Cherry County, Nebraska, reveals the following differences: size smaller; upper carnassial smaller and less swollen; first upper premolar smaller; bullae smaller and less rounded; external auditory meatus opens slightly dorsally rather than horizontally. Skulls from Archer County, Texas, show an intermediate condition of the teeth and bullae but are more like *nebracensis.*

Remarks.—Coyotes are fairly common from the river bottom up to 5000 feet elevation in the Chisos Mountains. Fresh tracks were observed in the trail below Laguna, on October 9, 1937, at 6000 feet elevation, and at Kibbe Spring, 5700 feet, on October 7, 1937. Coyotes rarely go to this height in the Chisos Mountains. One young was seen near Dugout, at about 2600 feet, on November 12, 1936. Fresh tracks and droppings were observed along Oak Creek, 5000 feet, on October 29, 1936. Tracks were recorded also at the mouth of Boquillas Canyon, along the base of Mesa de Anguila, at the Nail Ranch, about the Johnson Ranch, about the north end of Mariscal Mountain, and at the mouth of Mariscal Canyon. Coyotes were heard at several of these locations.

On October 24, 1937, the senior author saw a coyote loitering along the Mexican side of the Rio Grande at the mouth of Mariscal Canyon. It paid but little attention to him and after some twenty minutes entered the river a short distance downstream and swam across to the Texas shore. The river at this point was fairly rapid and about 100 yards wide.

Canis lupus monstrabilis Goldman

Gray Wolf

Canis lupus monstrabilis Goldman, Jour. Mammal., 18:42; February 14, 1937.

Remarks.—Reports from ranchers indicate that the wolf has been rare since the settlers arrived, but that a few occurred here, possibly as late as 1933.

Information obtained from local residents may be summarized as follows: Sam Nail, in his 28 years of residence in Brewster County, saw, and heard of, a few gray wolves in the vicinity of Terlingua Creek, Christmas Mountains, Burro Mesa, and Gano Spring; R. A. Serna saw a wolf near the mouth of Pine Canyon in 1933; Aaron Green knew of no gray wolves on the east or south sides of the Chisos Mountains since about 1920; Lloyd Wade saw one which had been trapped at the east base of the Christmas Mountains about 1914, and had also heard of one killed between Dugout and Lone Mountain about 1927; H. M. Wilson had not seen any wolves on the east side of the Chisos Mountains, where he has been ranching since February, 1929. A wild German shepherd dog and some supposed crosses between domestic dogs and wolves or coyotes were also reported. These may account for some of the more recent records.

Felis concolor stanleyana Goldman

Mountain Lion

Felis concolor youngi Goldman, Proc. Biol. Soc. Wash., 49:137, August 22, 1936.
Felis concolor stanleyana Goldman, Proc. Biol. Soc. Wash., 51:63, March 18, 1938 (substitute for *F. c. youngi* Goldman, not *Felis youngi* Pei).

Records of occurrence.—Specimens examined, 2: skull only no. 80339, and lower jaws only no. 80340, from the Chisos Mountains. Other record of occurrence: Boquillas (Goldman, 1936:138).

Measurements.—Adult female: greatest length of skull, 183; basal length, 157.4; zygomatic breadth, 124.6; interorbital constriction, 36.8; postpalatal length, 84.2; alveolar length of upper canine-premolar series, 55.8; length of crown of upper carnassial, 20.6; anteroposterior diameter of canine at alveolus, 12.6.

Comparisons.—Although the material available is insufficient for positive identification, it seems best to follow Goldman (*loc. cit.*) in referring the animals from this region to *F. c. stanleyana.* The measurements of the single adult female skull are near those given by Goldman in his original description.

Remarks.—Locally the mountain lion is commonly called panther. Lions are fairly numerous in the higher parts of the Chisos Mountains and occasionally range through the adjoining hills and on the flats.

Because they kill livestock, especially goats and sheep, panthers are regularly hunted by ranchers. The country is so rough and dry that dogs are rarely used; but traps, poisoned baits, and rifles take a heavy toll. Most of the panthers are taken in steel traps that are set "blind" in trails which they frequent.

Homer Wilson, who runs goats and sheep in the Blue Creek area, said that he killed approximately fifty-five lions between February, 1929, and December, 1937. Several were killed by other ranchers. Considering the large number that have been killed in the Chisos Mountains, it seems likely that the resident population is augmented by lions coming in from Mexico and the surrounding ranges in Texas.

Lynx rufus baileyi Merriam

Bobcat

Lynx baileyi Merriam, N. Amer. Fauna, 3:79, September 11, 1890.
Lynx rufus baileyi, Grinnell, Univ. Calif. Publ. Zoöl., 40:116, September 26, 1933.

Records of occurrence.—Specimen examined, 1: no. 80342, from E Base of Burro Mesa, 3500 feet. Other record of occurrence: E base of Chisos Mountains (Bailey, 1905:170).

Measurements.—Subadult female: total length, 770; tail vertebrae, 126; hind foot, 165; ear from crown, 64; basal length of skull, 99.6; basilar length, 97.1; length of nasals, 30.2; zygomatic breadth, 80.2; constriction posterior to supraorbital processes, 37.4; palatal length, 42.2; mastoidal breadth, 52.2; greatest length of upper carnassial at cingulum, 14.3.

Comparisons.—Skins of *L. r. baileyi* from Rainbow Canyon, Lincoln County, Nevada, and 17 miles E of Las Cruces, Dona Ana County, New Mexico, have darker upper parts than the skin from Burro Mesa. They also differ from the Big Bend specimen in having black stripes near the middorsal line and black spots laterally.

The skull of the Big Bend specimen differs from skulls of *L. r. baileyi* from Aso Sheep Ranch, Coconino County, Arizona, in the less inflated capsular part of the bulla and the slightly longer rostrum. Skulls from 20 miles east of Marathon, Brewster County, Texas, and 8 miles north of Hot Springs, Pecos County, Texas, are like the Big Bend specimen.

Remarks.—Bobcats are fairly common and widely distributed from the Rio Grande up to at least 5500 feet elevation. Tracks were observed at the base of the Mesa de Anguila, on Burro Mesa, at the Johnson Ranch, and along the river at the mouth of Mariscal Canyon. A subadult female was trapped at the edge of a dense thicket at the east base of Burro Mesa on March 26, 1937. Three bobcat tails and one skin were seen at a ranch near the southeast base of the Rosillos Mountains. On November 17, 1936, the senior author saw the skin of a bobcat which had been shot that day on Pulliam Bluff. It was a female and appeared to have recently suckled young.

Citellus variegatus couchii (Baird)

Rock Squirrel

Spermophilus couchii Baird, Proc. Acad. Nat. Sci. Phila., 1854–55:332, 1856.
Citellus variegatus couchii, Bailey, N. Amer. Fauna, 25:83, October 24, 1905.

Records of occurrence.—Specimens examined, 7: nos. 80343–80345; skeleton only 74336; Field Museum 46937–46939. These are distributed by localities as follows: Juniper Canyon, 4800 feet, 2; E of Basin, 5800 feet, 2; Green Gulch, 5200 feet, 3. Other records of occurrence: Chisos Mountains (Bailey, 1905:83); Boquillas and Chisos Mountains (Howell, 1938:141).

Measurements.—Two adult females: total length, 490, 443; tail vertebrae, 199, 194; hind foot, 60, 55; greatest length of skull, 60.9, 58.5; palatilar length, 29.2, 27.9; zygomatic breadth, 36.8, 36.0; cranial breadth, 25.5, 24.6; interorbital constriction, 13.9, 14.2; postorbital constriction, 17.1, 18.5; length of nasals, 21.2, 20.9; maxillary tooth row, 12.6, 13.1.

Comparisons.—These specimens resemble *C. v. couchii,* as known to us by Howell's (1938:139) account. One specimen is melanistic, the head and the anterior half of the back being black. Specimens taken in late July and early August are molting. The fore parts of the body are in new pelage, whereas patches of the faded pelage are still present on the other parts.

Remarks.—Rock squirrels were fairly common, in suitable habitats, from the Rio Grande up to 6900 feet elevation in the Chisos Mountains. A few were observed about cliffs and rocky outcrops along the Rio Grande and on the flats, but none was seen on the flats away from rocky outcrops. They were far more abundant in rocky places among the piñons and junipers in the Chisos Mountains, between 4000 and 6000 feet elevation, than in other localities. More rock squirrels were seen in Juniper Canyon than elsewhere. Here, at about 5000 feet elevation, thirty were observed on October 21, 1937. All except one of these were young of the year. The great variation in size indicated at least two litters. Nearly all the rock squirrels seen in October and November were immature, which indicates that most of the adults go into hibernation earlier than the young.

Citellus spilosoma major (Merriam)

Spotted Ground Squirrel

Spermophilus spilosoma major Merriam, N. Amer. Fauna, 4:39, October 8, 1890.
[*Citellus spilosoma*] *major,* Trouessart, Cat. Mamm., Sup., p. 340, 1904.

Specimens examined.—Three: nos. 80346–80348, from N end of Mariscal Mountain, 2300 feet.

Comparisons.—These specimens, taken in October, are in worn pelage. Comparison with *C. s. major,* as known to us by Howell's (1938:126) account, reveals no essential differences in coloration or features of the skull. The presence of this subspecies at the north end of Mariscal Mountain extends its reported range in this region about 90 miles southward.

Remarks.—The spotted ground squirrel was widely distributed but not common. It was confined almost entirely to the desert flats between 2200 and 4000 feet elevation. None were recorded in the river bottom. Dry rocky or sandy areas overgrown with creosote, cholla, and prickly pear provide the favored habitat.

These animals are extremely wary. In one small area where the senior author trapped three, not a live one was seen, although the area was under observation twice each day for five consecutive days. A few were seen in other places as they dashed across the road in front of the car. Occasionally they would hesitate at the edge of a clump of prickly pear, creosote, or other vegetation, beneath which their burrows were situated, but they usually disappeared upon reaching the burrows.

The spotted ground squirrel seems to hibernate in this area, as none was observed in November, 1936, although many trips were made through places where they had been seen in the summer. The latest fall record was of one observed near Glenn Spring on October 21, 1937.

Citellus interpres (Merriam)

Texas Antelope Squirrel

Tamias interpres Merriam, N. Amer. Fauna, 4:21, October 8, 1890.
Citellus interpres, Elliot, Field Columb. Mus. Publ., Zoöl. Ser., 4:143, 1904.

Records of occurrence.—Specimens examined, 5: nos. 80349–80351; skeleton only 81692; Univ. Mich. 74348. These are distributed by localities as follows: Pine Canyon, 4700 feet, 1; Green Gulch, 5200 feet, 2; The Basin, 5200 feet, 1; 13 miles N of Terlingua, 1. Other record of occurrence: Boquillas (Howell, 1938:180).

Measurements.—One adult male and one adult female: total length, 232, 240; tail vertebrae, 76, 80; hind foot, 38, 39; greatest length of skull, 39.6, 40.1; palatilar length, 17.6, 18.3; zygomatic breadth, 23.9, 24.4; cranial breadth, 19.0, 18.9; interorbital constriction, 10.0, 9.7; postorbital constriction, 14.5, 13.8; length of nasals, 11.8, 12.4; alveolar length of maxillary tooth row, 6.7, 6.7.

Comparisons.—The specimens from the Big Bend area closely resemble *C. interpres,* as known to us by specimens from Lincoln County, New Mexico, and also by Howell's (*loc. cit.*) revision, both in external features and skull measurements. The specimens taken in November are in full winter pelage. The specimen from Terlingua is an immature male taken on April 20.

Remarks.—Texas antelope squirrels were widely distributed from the river bottom up to 5500 feet elevation. They were found in the lower rocky canyons, on the creosote flats, and in the higher canyons among the piñons, junipers, and oaks. Although nowhere common, they were seen most frequently in the higher canyons.

If this squirrel hibernates in the Big Bend area, it is only during the coldest periods of the year. Several were seen in Green Gulch between November 12 and 15, 1936, and one was seen at the Nail Ranch on December 1, 1936. These squirrels are wary and secretive. In some places there were evidences of their foraging, and specimens were trapped where no live squirrels were seen.

Thomomys bottae limitaris Goldman

Botta Pocket Gopher

Thomomys lachuguilla limitaris Goldman, Jour. Wash. Acad. Sci., 26:118, March 15, 1936.
Thomomys bottae limitaris Goldman, Proc. Biol. Soc. Wash., 51:55, March 18, 1938.

Records of occurrence.—Specimens examined, 6: nos. 80352–80357. These are distributed by localities as follows: Green Gulch, 5200 feet, 2; E base of Burro Mesa, 3500 feet, 2;

Glenn Spring, 2606 feet, 1; Boquillas, 1800 feet, 1. Other records of occurrence: Boquillas (Bailey, 1915:89; Goldman, 1936a:119).

Measurements.—Average of 4 adult females: total length, 197 (193–204); tail vertebrae, 58 (56–60); hind foot, 26 (25–27); occipitonasal length, 31.9 (31.4–32–4); zygomatic breadth, 21.4 (20.5–21.9); breadth across squamosals (over mastoids), 18.0 (17.4–18.8); interorbital constriction, 6.9 (6.7–7.1); length of nasals, 11.6 (11.4–11.9); alveolar length of maxillary tooth row, 7.2 (6.9–7.4).

Comparisons.—These specimens resemble *T. b. limitaris,* as known to us by specimens from Boquillas, Comstock, 13 miles below Juno on Devils River, Marathon, and Samuels, Texas, in the following features: upper parts Pinkish Buff to Ochraceous with top of head and back somewhat darkened by black-tipped hairs; muzzle brownish or blackish; ears and postauricular patches black; forearms and thighs Pale Buff or white; feet white; under parts Pale Cinnamon to white; proximal part of tail Pale Buff above; premaxillae extending slightly or not at all back of nasals; nasals truncate posteriorly; anterior part of zygomatic arch turns medially at sharp angle; basisphenoid enlarged at junction with basioccipital; incisors decurved and slightly procumbent. The Big Bend animals cannot be definitely distinguished from *T. b. lachuguilla,* as known to us by topotypes from El Paso, Texas, by the external features alone, but the features of the skull definitely identify them as *limitaris.*

Remarks.—These gophers are widely distributed from about 2000 to 5500 feet elevation, on the dry, rocky flats and the lower slopes of the mountains. The burrows and mounds are usually small, probably because the soil is extremely hard and rocky. They were usually situated about prickly pear, other cacti, and agave, and were most numerous about *Agave lecheguilla.* Lecheguilla usually grows in large clumps, parts of which are often undermined and killed. The molt occurs throughout the year.

Cratogeomys castanops lacrimalis Nelson and Goldman

Chestnut-faced Pocket Gopher

Cratogeomys castanops lacrimalis Nelson and Goldman, Proc. Biol. Soc. Wash., 47:137, June 13, 1934.

Records of occurrence.—Specimens examined, 11: nos. 80358–80361; skeletons only 80362, 80363, 84139–84141; Univ. Mich. 79101, 79102. These are distributed by localities as follows: One mile SW of Boquillas, 1850 feet, 3; Big Bend of Rio Grande, 2000 feet, 6; Johnson Ranch, 2060 feet, 2. Other record of occurrence: Boquillas (Nelson and Goldman, 1934:138).

Measurements.—One adult male: total length, 285; tail vertebrae, 77; hind foot, 38; basal length of skull, 53.7; basilar length, 47.8; zygomatic breadth, 37.7; width across squamosals over the mastoids, 30.9; interorbital constriction, 7.9; length of nasals, 19.6; maxillary tooth row, 9.9; width of cutting edge of upper incisors, 6.7. Average of 4 adult females: total length, 266 (255–274); tail vertebrae, 74 (68–77); hind foot, 36.3 (35.9–37.0); basal length of skull, 50.5 (49.6–50.9); basilar length, 43.4 (41.9–44.5); zygomatic breadth, 32.8 (29.8–34.6); width across squamosals over the mastoids, 29.9 (27.9–30.8); interorbital constriction, 7.2 (6.9–7.4); length of nasals, 17.5 (17.1–18.0); maxillary tooth row, 9.5 (8.9–9.7); width of cutting edge of upper incisors, 6.3 (6.1–6.5).

Comparisons.—These specimens resemble *C. c. lacrimalis,* as known to us by Nelson and Goldman's (*loc. cit.*) description, in the following features: the

upper parts vary from Pinkish Buff to Cinnamon Buff and are slightly darkened on the head and back by dusky-tipped hairs; under parts white to Pinkish Buff; ears dusky; fore feet pale buffy; hind feet whitish. The brain case is low and flat; the nasals are broad anteriorly; the lacrimals are large; the upper incisors are rather strongly recurved; the auditory bullae are not strongly inflated.

The animals from the Big Bend also closely resemble *C. c. clarkii,* named from the Mexican side of the Rio Grande and of which we have examined no specimens.

Remarks.—These large pocket gophers were common along the river. Their conspicuous mounds of earth were found throughout the sandy-loam river bottom but were absent in the dry rocky soil away from the river. They were especially common about Castolon and the Johnson and Daniel ranches, where tracts of the river bottom are, or have been, cultivated. Only in a few places were the ranges of the chestnut-faced pocket gopher and the Botta pocket gopher found to overlap.

Perognathus merriami gilvus Osgood

Merriam Pocket Mouse

Perognathus merriami gilvus Osgood, N. Amer. Fauna, 18:22, September 20, 1900.

Specimens examined.—Four: nos. 80366–80369, from N end of Mariscal Mountain, 2300 feet.

Measurements.—Two adult males and one adult female: total length, 118, 113, 113; tail vertebrae, 61, 58, 56; hind foot, 15, 16, 16; ear from notch, 6, 6, 6; greatest length of skull, —, 20.2, 20.5; basilar length, 14.1, 14.1, 14.3; zygomatic breadth, 10.4, 10.0, 10.4; mastoidal breadth, 11.2, 10.7, 11.4; length of nasals, 7.5, 7.5, 7.8; depth of rostrum in front of premolars, 4.6, 4.8, 4.8; interorbital constriction, 4.6, 4.9, 4.6; diastema, 4.9, 5.2, 5.1; length of interparietal, 2.5, 2.0, 2.4; width of interparietal, 3.3, 3.1, 3.1.

Comparisons.—Comparison of the animals from Mariscal Mountain with *P. m. merriami,* as known to us by specimens from Eagle Pass, Maverick County, Texas, and with *P. m. gilvus,* as known to us by a specimen from 44 miles northwest of Roswell, New Mexico, by animals from Casas Grandes Viejo, Chihuahua, Mexico, and by Osgood's (1900:22) description, reveals the following unique features: tail relatively longer, equal to or longer than the length of head and body; tail less hairy; basilar length of skull less; dorsal surface of rostrum more sloping; zygomatic process of maxilla weaker. The upper parts are paler, more nearly Cinnamon Buff than in *merriami* and the Casas Grandes Viejo specimens. The rostrum is slenderer and shallower and the lower incisors and anterior part of the mandible are weaker than in *merriami* and the Roswell specimens. The auditory bullae are larger than in *merriami* and smaller than in the Casas Grandes Viejo specimens. The upper incisors are smaller and more recurved than in *merriami.* The mastoids are broader than in the Casas Grandes Viejo specimens.

It is evident that the Mariscal Mountain specimens most closely resemble *gilvus* in both color and proportions of the skull, but the differences lead us to the opinion that a new race is present here. This opinion is strengthened by

Osgood's (1900:23) statement that specimens from Comstock and Washburn, referred by him to *merriami,* are intergrades between *merriami* and *gilvus.* The Comstock specimens are probably intermediates between *merriami* and the Mariscal Mountain specimens, whereas those from Washburn are intergrades between *merriami* and *gilvus,* as stated. Thus, *gilvus* is diverging from typical *merriami* to the northwest, and the Mariscal Mountain specimens are diverging to the west. Since sufficient material is not available for positive verification of the opinions given above, it seems best to refer the specimens tentatively to *P. m. gilvus.*

Remarks.—Merriam pocket mice were rare. Four specimens were obtained in October, 1937, in a sandy flat at the north end of Mariscal Mountain. Three of these were taken beside clumps of prickly pear and one beneath a small bush. *Dipodomys merriami ambiguus* and the two larger species of *Perognathus* found in the area were abundant in this locality. Trapping at many other sandy sites was without result. They did not appear to inhabit the river bottom or sandy washes which are subject to flooding. Extensive tracts of hard, rocky soil probably are effective barriers to the dispersal of the Merriam pocket mouse.

Perognathus penicillatus eremicus Mearns

Desert Pocket Mouse

Perognathus (Chaetodipus) eremicus Mearns, Bull. Amer. Mus. Nat. Hist., 10:300, August 31, 1898.

Perognathus penicillatus eremicus, Osgood, N. Amer. Fauna, 18:48, September 20, 1900.

Records of occurrence.—Specimens examined, 51: nos. 80372–80391; skeletons only 74337, 74338, 80407–80410, 84142–84144; Univ. Mich. 79308–79310, skulls only 79311–79327; Field Museum 46912, 46913. These are distributed by localities as follows: Gano Spring, 3400 feet, 1; E base of Burro Mesa, 4400 feet, 4; Boquillas, 1800 feet, 3; Glenn Spring, 2606 feet, 3; N end of Mariscal Mountain, 2300 feet, 3; Big Bend of Rio Grande, 2000 feet, 28; mouth of Santa Helena Canyon, 2146 feet, 6; NE base of Mesa de Anguila, 3000 feet, 3. Other record: Boquillas and E base of Chisos Mountains (Bailey, 1905:138).

Measurements.—Average of 10 adult males from the Big Bend of the Rio Grande: total length, 177 (156–190); tail vertebrae, 99 (87–107); hind foot, 23 (21–24); basilar length of skull, 18.1 (17.3–18.9); zygomatic breadth, 13.2 (12.6–13.9); length of nasals, 10.5 (10.2–10.9); depth of rostrum in front of premolars, 6.5 (6.3–6.8); interorbital constriction, 6.6 (6.3–6.9); diastema, 6.6 (6.4–6.9); greatest length of interparietal, 3.4 (3.2–3.7) greatest width of interparietal, 7.0 (6.7–7.4); distance between stylomastoid foramina, 10.1 (9.5–10.4); length of bulla from stylomastoid foramen to anterior tip, 6.3 (6.1–6.5).

Comparisons.—The average difference between the Big Bend specimens and topotypes of *P. p. eremicus* from Fort Hancock, Texas, is slight. The interparietal is smaller and the upper parts are more nearly Pinkish Buff. Comparison with *eremicus* from White Sands, Otero County, New Mexico, Cochise County, Arizona, 2 miles west of Ahumada, and 1 mile east of Samalayuca, Chihuahua, Mexico, shows that the specimens from Texas are lighter and that there is a tendency toward darker coloration in the marginal parts of the range. Because of their variability measurements of the length of the nasals and the length and breadth of the interparietal are only of general diagnostic value. The depth of the rostrum, the interorbital constriction, the diastema, and the size of the bullae are remarkably uniform.

Remarks.—The desert pocket mouse was by far the most abundant mammal in the Lower Sonoran life zone. It was plentiful in the river bottom and in every wash and sandy area up to about 3500 feet elevation. Usually every trap line in a sandy area produced more specimens of this mouse than of all other species combined. It was taken among cane and *Baccharis* along the river and among all types of desert vegetation on the flats and in the washes. In houses it was almost as common as the white-footed mouse, but was less wary and often ran about the rooms in the evenings, paying little attention to people or lights.

Perognathus nelsoni canescens Merriam

Nelson Pocket Mouse

Perognathus (Chaetodipus) intermedius canescens Merriam, Proc. Acad. Nat. Sci. Phila., 1894:267, September 27, 1894.

Perognathus nelsoni canescens, Osgood, N. Amer. Fauna, 18:54, September 20, 1900. Type from San Antonio de Jaral, Coahuila, Mexico.

Perognathus collis collis Blair, Occas. Papers Mus. Zoöl. Univ. Mich., 381:1, June 20, 1938. Type from Limpia Canyon, about one mile northwest of Fort Davis, Davis Mountains, Jeff Davis County, Texas.

Perognathus collis popei Blair, Occas. Papers Mus. Zoöl. Univ. Mich., 381:3, June 20, 1938. Type from Pinnacle Spring, Johnson Ranch, Big Bend of the Rio Grande, Brewster County, Texas.

Records of occurrence.—Specimens examined, 29: nos. 80392–80405, 80411, 80413; skeletons only 80406, 80412, 81687, 84145; Univ. Mich. 79300–79302, 79304–79307; Field Museum 46910, 46911. These are distributed by localities as follows: Chisos Mountains, 1; Pine Canyon, 4700 feet, 8; Juniper Canyon, 4800 feet, 2; Boquillas, 1; Glenn Spring, 2600 feet, 4; N end of Mariscal Mountain, 2300 feet, 3; Pinnacle Spring, 2800 feet, 9; Smoky Spring, 3200 feet, 1. Other record of occurrence: Boquillas and E base of Chisos Mountains (Bailey, 1905:140).

Measurements.—Average of 11 adult males: total length, 187 (170–201); tail vertebrae, 104 (93–116); hind foot, 22.2 (22–23); ear from crown, 5.0 (4.0–6.0); occipitonasal length, 25.5 (24.2–26.5); frontonasal length, 16.8 (16.0–17.3); interorbital constriction, 6.4 (6.1–6.7); mastoidal breadth, 13.2 (12.8–13.8); length of mastoid, 8.2 (7.8–8.6); distance between stylomastoid foramina, 10.5 (10.0–10.8).

Comparisons.—Seasonal variation in color is greater in topotypes of *P. n. canescens* than is usual in *Perognathus.* The pelage is lightest in April and becomes progressively darker until September. Specimens from the Chisos Mountains average darker than those from the lower elevations taken in the same season. Exceptionally, specimens taken in the spring are almost as dark as topotypes of *P. n. nelsoni,* named from Hacienda de la Parada, San Luis Potosi, Mexico, whereas other animals taken at the same place and same time are much lighter. The specimens from the Chisos Mountains are indistinguishable in color from those taken at Langtry and Comstock, Val Verde County, Texas. The upper parts and the dorsal tail stripe average slightly lighter than in specimens from the Davis Mountains (20 miles south of Toyahvale, 1 mile northwest of Fort Davis, and Alpine), or in topotypes of *canescens,* but about 40 per cent of the specimens from the Chisos Mountains are indistinguishable. No consistent differences in the size of the spines on the rump, the coarseness of the hairs on the hind legs, or the size of the annulations on the tail are discernible.

The frontonasal length in the specimens from the Chisos Mountains averages slightly more than in two comparable specimens from the Davis Mountains, one of which is a topotype of *P. collis collis*. This greater average frontonasal length is the only constant difference between these two populations. Because the range of variation in this measurement of the Langtry-Comstock specimens, to the eastward, covers the combined ranges of variation of the above two groups, this difference is apparently not of diagnostic value. There is a gradual decrease in the frontonasal length with increasing distance northward from the type locality.

The interparietal of topotypes of *canescens* varies from strap-shaped to pentagonal; in most specimens it is strap-shaped. Most of the Big Bend specimens have a pentagonal and slightly larger interparietal. Of six specimens from Langtry and Comstock, three have strap-shaped interparietals and three have pentagonal interparietals. The size and shape of the mastoid bone and the size of the tubercle on the outside of the mandible in the Chisos Mountains specimens show no consistent differences from topotypes of *canescens*.

The specimens from the Chisos Mountains differ from topotypes of *nelsoni* in the following features: color of upper parts lighter; frontonasal length less; rostrum weaker; interparietal more pentagonal and larger; mastoids larger. These are also differences between topotypes of *nelsoni* and topotypes of *canescens,* but the differences are not as distinct. The specimens from the Chisos Mountains and Davis Mountains are extremes with respect to these diagnostic characters and the topotypes of *canescens* are intermediates between them and *nelsoni*.

The accumulation of material from the type localities of *P. n. nelsoni, P. n. canescens,* and *P. c. popei,* since the original descriptions of *P. collis collis* and *P. collis popei* (Blair, 1938:1 and 3), shows clearly the relationship of these forms to *nelsoni* and establishes their identity with *canescens*. Although the populations named *collis* and *popei* do show the extremes of the characters here assigned to the subspecies *canescens,* the differences appear to be too slight to warrant subspecific recognition.

Remarks.—The Nelson pocket mouse was not numerous but was taken in several localities about the base of the Chisos Mountains from 2300 to 4800 feet elevation. Its range overlapped that of the desert pocket mouse, but in general the habitats of the two were not the same. This pocket mouse inhabited hard, rocky areas which were occasionally overgrown with grass, sotol, and bear grass. This was the condition at 4700 feet elevation in Pine Canyon, where seven specimens were trapped. No specimens were obtained in sandy washes favored by the desert pocket mouse.

Dipodomys merriami ambiguus Merriam

Merriam Kangaroo Rat

Dipodomys ambiguus Merriam, N. Amer. Fauna, 4:42, October 8, 1890.
[*Dipodomys merriami*] *ambiguus* Elliot, Field Columb. Mus. Publ., Zoöl. Ser., 2:234, 1901.

Records of occurrence.—Specimens examined, 16: nos. 80414–80421, 80423, 80427, 80428; skeletons only 80422, 80424–80426, 74339. These are distributed by localities as follows:

Rough Run, 3000 feet, 1; E base of Burro Mesa, 3500 feet, 3; 1 mile SW of Boquillas, 1850 feet, 1; N end of Mariscal Mountain, 2300 feet, 9; mouth of Santa Helena Canyon, 2146 feet, 1; N end of Mesa de Anguila, 2300 feet, 1. Other record of occurrence: Boquillas (Bailey, 1905:150).

Measurements.—Average of 5 adult males: total length, 241 (230–252); tail vertebrae, 141 (131–148); hind foot, 37.4 (35–40); ear from crown, 10 (8–11); greatest length of skull, 35.5 (33.9–36.6); condylobasal length, 26.6 (25.8–27.2); zygomatic breadth, 17.1 (16.8–17.6); width of nasals at anterior end, 3.2 (3.1–3.5); length of nasals, 13.1 (12.1–13.7); breadth of skull across bullae, 22.5 (22.0–23.3).

Comparisons.—*D. m. ambiguus* is most closely related to *D. m. merriami*, from which it cannot be distinguished by external characters alone. A comparison of the Big Bend specimens with topotypes of *merriami* shows the following differences: ears shorter; cutting edges of upper incisors shorter and forming a greater angle with anterior surface; maxillary part of bony palate between incisive foramina and plane of first molars broader; sides of maxillae in front of first molars less concove. On the average the tail is shorter and the bullae are less inflated.

Specimens from El Paso, El Paso County, Texas, near the type locality of *ambiguus*, resemble the specimens from the Big Bend in the appearance of the upper incisors and the maxillary part of the bony palate, but show an intermediate condition between typical *merriami* and the Big Bend specimens in all other characters mentioned. Specimens from 1 mile east of Strauss, Dona Ana County, and from Otero County, New Mexico, are referable to *merriami*.

Remarks.—The Merriam kangaroo rat is common in the river bottom and in sandy areas up to 3500 feet elevation. It was found in all suitable situations but was most numerous in a sandy flat at the north end of Mariscal Mountain.

Dipodomys ordii attenuatus Bryant

Ord Kangaroo Rat

Dipodomys ordii attenuatus Bryant, Occas. Papers Mus. Zoöl. Louisiana State Univ., 5:65, November 10, 1939.

Specimens examined.—Five: nos. 80429–80431; Univ. Mich. 79121, 79122. These are from: mouth of Santa Helena Canyon, 2146 feet, 2; Big Bend of Rio Grande, 2000 feet, 1; Johnson Ranch, 2.

Measurements.—Average of 4 adult males: total length, 239 (228–245); tail vertebrae, 135 (127–143); hind foot, 36.7 (36–37); ear from notch, 11.4 (11.2–11.5); greatest length of skull, 36.2 (35.5–36.6); condylobasal length, 27.1 (26.4–27.8); spread of maxillary arches, 19.1 (18.8–19.5); width of rostrum at anterior end, 3.5 (3.3–3.8); length of nasals, 13.2 (12.8–14.1); breadth of skull across bullae, 22.9 (22.2–23.4).

Comparisons.—*D. o. attenuatus* is about the same size as *D. o. ordii*, as known to us by topotypes, but differs from it in the following features: color of upper surface and sides paler, more buffy and less golden; skull smaller in all measurements taken except length of nasals and frontonasal length; rostrum weaker; spread of maxillary arches relatively less, which, combined with the weaker rostrum, gives the skull an acutely pointed and triangular appearance; auditory bullae smaller; basioccipital narrower.

Remarks.—The Ord kangaroo rat was rare and appeared to be confined to the river bottom.

Castor canadensis mexicanus Bailey

Beaver

Castor canadensis mexicanus Bailey, Proc. Biol. Soc. Wash., 26:191, October 23, 1913.

Specimen examined.—One unsexed adult, no. 81546, from Johnson Ranch, 2060 feet.

Measurements.—No external measurements; occipitonasal length, 132.4; basilar length, 116.3; condylobasal length, 130.9; zygomatic breadth, 95.2; interorbital constriction, 24.7; mastoidal breadth, 60.4; length of nasals, 47.5; width of nasals, 26.6; alveolar length of maxillary tooth row, 32.1.

Comparisons.—This specimen shows no essential differences from *C. c. mexicanus,* as known to us by skulls from 9 miles east of Fort Hancock, Hudspeth County, Texas, and by Bailey's (1913 :191) description.

Remarks.—Tracks, gnawed branches, and slides showed that beavers were present along the Rio Grande from the mouth of Santa Helena Canyon to the mouth of Boquillas Canyon. No evidences of dams or houses were observed but several dens in the bank of the river were seen.

Onychomys torridus torridus (Coues)

Grasshopper Mouse

Hesperomys (Onychomys) torridus Coues, Proc. Acad. Nat. Sci. Phila., 1874:183, December 15, 1874.

Onychomys torridus, Merriam, N. Amer. Fauna, 2:3, October 30, 1889.

Specimen examined.—One adult female, no. 80432, from Gano Spring, N base of Burro Mesa, 3400 feet.

Measurements.—Total length, 149; tail vertebrae, 54; hind foot, 21; ear from notch dry, 14.7; condylobasal length, 23.9; zygomatic breadth, 12.9; interorbital constriction, 4.6; breadth of brain case, 11.3; length of nasals, 10.4; maxillary tooth row, 4.0.

Comparisons.—The features which place this specimen in the species *torridus,* as opposed to the species *leucogaster,* are as follows: the tail is relatively longer, more than half the length of head and body; the interorbital region of the skull is relatively wider; the teeth are lower crowned; the first upper molar is narrow and elongated and is one-half as long as the maxillary tooth row; the third upper molar is wider than long. *O. leucogaster* may occur in the Chisos Mountains area, although we do not know of any specimens taken there.

O. t. torridus, the subspecies which the specimen from the Chisos Mountains most closely resembles, is known to us by animals from Camp Grant, Graham County, and Cochise County, Arizona, and from Socorro, Hildalgo, Otero, and Eddy counties, New Mexico, and also from Hollister's (1914:456) account. Features of agreement with *O. t. torridus* are as follows: the upper parts are Vinaceous Buff; the ear tufts show little contrast with the surrounding color; the under parts are pure white, the white extending well up the sides of the body and cheeks; the under fur for one-half its length is dark neutral gray; the fore legs and the fore feet are pure white; the anterior palatine foramina are large and extend back to the plane of the anterior edges of the first upper molars; the posterior margin of the palate is concave and has no projecting spine. The measurements of the skull and the external measurements, with the exception of the points mentioned below, are similar.

Differences from *O. t. torridus* are as follows: the tail is pale buffy above, has a covering of whitish hairs, and there is no marked distinction between the upper surface and the tip; the nasals and the maxillary tooth row are longer and the width of the brain case is less; the cranium is slightly convex at the anterolateral margins of the parietals and its anterior part is less truncate, these features giving it an oval outline when viewed from above. The shape of the cranium distinguishes the Chisos Mountains specimen from all except two other available specimens, these being numbers 51554 and 51556, from 5 miles east of Carlsbad Caverns, Eddy County, New Mexico. The color of the tail of the Big Bend specimen is distinctive. The only specimens comparable with this animal in the length of the nasals and maxillary tooth row are those reported by Hollister (1914:481–482) from Fort Lancaster, Sierra Blanca, and Marathon, Texas.

The present specimen is tentatively referred to *O. t. torridus*. More material from the Chisos Mountains area will be necessary for certain determination of the subspecies in that area.

Remarks.—This species is apparently rare within the area, as extensive trapping yielded only one specimen.

Reithrodontomys fulvescens canus Benson

Fulvous Harvest Mouse

Reithrodontomys fulvescens canus Benson, Proc. Biol. Soc. Wash., 52:149, October 11, 1939.

Specimens examined.—Three: nos. 80433 and 80434, from Pine Canyon, 4700 feet; Field Museum 46936, from Juniper Canyon, 4800 feet.

Measurements.—One adult female and two adult males: total length, 174, 167, 180; tail vertebrae, 95, 95, 116; hind foot, 19, 19, 20; ear from notch dry, 12, 12, 13; greatest length of skull, 21.4, 22.2, 22.0; breadth of brain case, 10.0, 10.4, 10.4; length of nasals, 8.2, 8.2, 9.1; width of outer wall of infraorbital foramen, 2.0, 2.1, 2.3.

Comparisons.—These specimens resemble *R. f. canus* (as known to us by animals from 14 miles east of Zarca, Durango, Mexico, and from 9 miles southeast of San Lucas, and Cañon Gotera, Chihuahua, Mexico) but differ in having less gray on the neck and shoulders. They are lighter in color than *intermedius,* as known to us by Howell's (1914:47) description, and have a greater inflation of the cranium than *fulvescens,* from 2 miles east of Peña Blanca, Santa Cruz County, Arizona.

Remarks.—Harvest mice are rare in the Big Bend area. Two specimens were taken in the bottom of Pine Canyon (pl. 5, *b*) in May, 1937. The canyon was fairly level at this place and was overgrown with a dense stand of sotol and grama and other grasses.

Peromyscus eremicus eremicus (Baird)

Cactus Mouse

Hesperomys eremicus Baird, Pac. R. R. Rept., Mamm., 8:479, 1857.
Peromyscus eremicus, Allen, Bull. Amer. Mus. Nat. Hist., 7:226, June 29, 1895.

Records of occurrence.—Specimens examined, 39: nos. 80445–80463, 80565, 80566; skeletons only 74340, 80482–80485, 81688, 84147; alcoholics 80760, 80761; Field Museum 46930, 46932–46935; Univ. Mich. 79210–79213. These are distributed by localities as follows: Flat NE of Chisos Mountains, 3800 feet, 3; Tornillo Flat, 2800 feet, 2; N base of Burro

Mesa, 3000 feet, 1; E base of Burro Mesa, 3600 feet, 4; SW of Boquillas, 1850 feet, 2; Glenn Spring, 2606 feet, 4; N end of Mariscal Mountain, 2300 feet, 2; Big Bend of Rio Grande, 2000 feet, 12; Mesa de Anguila, 2400 feet, 2; Pinnacle Spring, 2800 feet, 3; mouth of Santa Helena Canyon, 2146 feet, 4. Other records of occurrence: Boquillas (Bailey, 1905:101; Osgood, 1909:242).

Measurements.—Average of 24 adults, male and female: total length, 184 (160–205); tail vertebrae, 97 (82–113); hind foot, 20.4 (19–21); ear from notch dry, 15.2 (14–16); greatest length of skull, 24.8 (24.0–26.4); basilar length, 18.8 (17.8–19.5); zygomatic breadth, 12.5 (11.9–13.3); interorbital constriction, 4.0 (3.8–4.1); length of nasals, 9.0 (8.1–9.7); shelf of bony palate, 3.9 (3.4–4.5); palatine slits, 4.8 (4.5–5.0); diastema, 6.2 (5.8–6.6); postpalatal length, 9.0 (8.4–9.8); maxillary tooth row, 3.7 (3.6–4.1).

Comparisons.—*P. e. eremicus* shows a great variation in the color of the upper parts from pale buff to almost black. It has two main areas of occurrence: one in the vicinity of the Colorado River in California, Nevada, Arizona, and Mexico, and the other in western Texas, New Mexico, and adjacent parts of Mexico. The range of *P. e. anthonyi* is between the two areas of occurrence of *eremicus.* Considering this range it is striking to find that the color of the Big Bend specimens, from near the center of the eastern area of occurrence of *eremicus,* more closely resembles that of animals from the type locality near Yuma, Arizona, than either *eremicus* from New Mexico or *anthonyi.*

Although the Big Bend specimens resemble typical *eremicus,* as known to us by specimens taken within forty miles of the type locality, they differ in several respects. However, all the differences noted are of an average kind, so that no one individual character can be relied upon to distinguish all the eastern animals from all those from the more western area of occurrence. About 80 per cent of the specimens from the Chisos Mountains area differ from the western specimens in the following features: upper parts less buffy; top of head gray with little buff; buff of the cheeks lighter and less extensive; ears shorter; cranium more inflated in the parietal region and the posteromedial wall of the orbit directed more anteriorly. Also, in the specimens from the Chisos Mountains the following may be noted: the posterior part of the zygomatic arch is more nearly vertical at its junction with the squamosal; the shelf of the bony palate and the maxillary tooth row are relatively shorter; and the bar separating the squamosal foramina is inclined more anteriorly.

The form *P. e. arenarius,* described by Mearns in 1896 and placed in synonymy by Osgood (1909:239), is intermediate between the Big Bend specimens and typical *eremicus* in a number of features. Topotypes of *arenarius* are like *eremicus* in color, are intermediate in the proportions of the skull, and have short ears like the Big Bend specimens.

Because we cannot distinguish all the specimens from the Big Bend from all the comparable specimens from a selected locality within the western area of occurrence of *eremicus,* and also because the topotypes of *arenarius* in several features show greater resemblance to the western animals than do the specimens from the Big Bend, we have decided against recognizing an eastern race under the name of *arenarius,* and follow Osgood in referring specimens from the Big Bend to the subspecies *eremicus;* this in spite of a confessed distrust of a geographical arrangement whereby, in a continuously distributed

species, the range of one subspecies is divided into two parts by the range of another. Although such appears (Osgood, 1909 :240, fig. 11) to be the arrangement here adopted by us, the two seemingly separated populations or *eremicus* are probably connected by animals from the territory to the north of the range of *anthonyi*.

Remarks.—This mouse was more abundant than any other species of *Peromyscus* in the hot dry areas below 3500 feet elevation. It was found most frequently at the base of cliffs, but specimens were taken from washes and about scattered rocky outcrops. In these places vegetation, mostly desert shrubs, was sparse and water was usually lacking.

Peromyscus maniculatus blandus Osgood
Deer Mouse

Peromyscus sonoriensis blandus Osgood, Proc. Biol. Soc. Wash., 17:56, March 21, 1904.
Peromyscus maniculatus blandus Osgood, N. Amer. Fauna, 28:84, April 17, 1909.

Records of occurrence.—Specimens examined, 7: nos. 80435–80440; Univ. Mich. 79206. These are distributed by localities as follows: E base of Burro Mesa, 3500 feet, 5; N end of Mariscal Mountain, 2300 feet, 1; Johnson Ranch, 2060 feet, 1. Other records of occurrence: Bone Spring, 53 miles S of Marathon (Bailey, 1905:97; Osgood, 1909:86).

Measurements.—Average of 4 adults, 2 males and 2 females: total length, 154 (145–169); tail vertebrae, 63 (61–66); hind foot, 20.8 (20–21); ear from notch dry, 14.8 (14–15); greatest length of skull, 24.6 (23.7–25.5); basilar length, 19.1 (18.3–20.0); zygomatic breadth, 12.6 (11.8–13.1); interorbital constriction, 4.0 (4.0–4.1); length of nasals, 10.5 (9.9–11.0); shelf of bony palate, 3.9 (3.6–4.2); palatine slits, 5.3 (5.2–5.3); diastema, 6.5 (6.2–6.8); postpalatal length, 8.9 (8.5–9.4); maxillary tooth row, 3.8 (3.7–3.9).

Comparisons.—These specimens cannot be distinguished from *P. m. blandus*, as known to us by specimens from Animas Valley, Hidalgo County, New Mexico. The specimens available indicate a trend toward the gray phase, as two of the adults are typical of that phase and two show only slight variations toward the buff phase. The pelage of the young is similar to that of the adults in the gray phase.

Remarks.—The deer mouse is rare and localized in distribution. Bailey (*loc. cit.*) states that this species lives primarily in small valleys of loam which lie in the lower edge of the Upper Sonoran zone and which support a moderate growth of vegetation. Our observations verify this statement. At the Nail Ranch they were common among weeds and brush near cultivated fields. A few were taken among cane and *Baccharis* at the Johnson ranch. Several were taken on the Daniel Ranch among tules at the edge of a small pond and in the adjacent grass and weeds. Only two specimens were taken in dry areas away from water. The spotty distribution of the deer mouse is probably due to exacting environmental requirements.

Peromyscus leucopus texanus (Woodhouse)
Wood Mouse

Hesperomys texana Woodhouse, Proc. Acad. Nat. Sci. Phila., 1852–53:242, 1854.
Peromyscus leucopus texanus, Osgood, N. Amer. Fauna, 28:127, April 17, 1909.

Specimens examined.—Eleven: nos. 80441–80444, 80464; skeletons only 80486, 80487, 84146; Univ. Mich. 79195, 79207, 79208. These are distributed by localities as follows: E

base of Burro Mesa, 3500 feet, 1; one mile SW of Boquillas, 1850 feet, 5; Big Bend of Rio Grande, 2000 feet, 2; Johnson Ranch, 2060 feet, 3.

Measurements.—Average of 7 adults: total length, 164 (151–176); tail vertebrae, 75 (63–81); hind foot, 21.4 (20–23); ear from notch dry, 14.7 (13–17); greatest length of skull, 26.2 (25.2–27.1); basilar length, 19.9 (19.2–20.6); zygomatic breadth, 13.5 (12.7–14.2); interorbital constriction, 4.2 (3.9–4.4); length of nasals, 10.3 (9.8–10.9); shelf of bony palate, 4.2 (4.0–4.4); palatine slits, 5.1 (4.6–5.6); diastema, 6.9 (6.5–7.3); postpalatal length, 9.5 (9.0–9.9); maxillary tooth row, 3.8 (3.7–4.0).

Comparisons.—These specimens come from a district between the ranges of typical *P. l. tornillo* and *P. l. texanus* and show intergradation between the two. Comparison with *tornillo,* as known to us by specimens from Hemphill County, Texas, Otero County, New Mexico, and Las Animas County, Colorado, and with *texanus,* as known from Osgood's (1909:127) account, shows that the animals are nearer *texanus.*

Features of difference from *tornillo,* which are also features of agreement with *texanus,* are as follows: unworn pelage more dusky; ground color darker fawn, becoming slightly reddish in the worn condition and more concentrated in the middorsal line; lateral line indistinct and narrow, slightly lighter than sides; tail darker above; skull smaller; maxillary tooth row shorter; junction of zygomatic arch with maxilla weaker; lower jaw weaker; outer tubercle of mandible less prominent.

The Big Bend specimens more closely resemble *tornillo* in the greater length of the nasals, palatine slits, and postpalatal measurement. They differ from both *tornillo* and *texanus* in the weaker incisor teeth and weaker development of the anterior end of the mandible.

Remarks.—A few mice were taken among tules and cane along the river bottom. The only specimens not taken along the Rio Grande were trapped near a spring on the Nail Ranch.

Peromyscus boylii rowleyi (Allen)

Brush Mouse

Sitomys rowleyi Allen, Bull. Amer. Mus. Nat. Hist., 5:76, April 28, 1893.

P[*eromyscus*]. *b*[*oylii*]. *rowleyi,* Mearns, Preliminary diagnoses of new mammals from the Mexican border of the United States, p. 3, May 25, 1896.

Specimens examined.—Twenty-one: nos. 80467–80481; skeletons only 74341–74343, 81689–81691. These are distributed by localities as follows: Pine Canyon, 4700 feet, 5; Green Gulch, 5000 feet, 8; Oak Creek, 5000 feet, 6; Laguna Meadow, 6500 feet, 2.

Measurements.—Average of 16 adults: total length, 202 (185–218); tail vertebrae, 108 (95–117); hind foot, 21.4 (20–22); ear from notch dry, 15.8 (13–17); greatest length of skull, 27.4 (26.0–28.4); basilar length, 20 (18.9–21.0); zygomatic breadth, 13.7 (13.0–14.3); interorbital constriction, 4.6 (4.4–4.7); length of nasals, 10.2 (9.4–11.3); shelf of bony palate, 4.3 (4.0–4.5); palatine slits, 5.2 (4.6–5.6); diastema, 7.0 (6.5–7.4); postpalatal length, 9.8 (9.2–10.4); maxillary tooth row, 3.9 (3.8–4.1).

Comparisons.—Since Osgood (1909:148) referred specimens from the Davis Mountains, which are about 120 miles north of the Chisos Mountains, to *P. b. attwateri,* it was expected that the Chisos Mountains specimens also would be referable to *attwateri.* They prove to be referable instead to *P. b. rowleyi,* as known to us by specimens from Zion Canyon, Washington County, Utah;

Rainbow Bridge, San Juan County, Utah; Hualapai Peak, Mojave County, Arizona; Tower House, Mesa Verde National Park, Colorado; Water Canyon, Socorro County, New Mexico; and 3 miles southwest of Santa Rita, Grant County, New Mexico.

Features of difference from *attwateri,* which are at the same time features of agreement with *rowleyi,* are: color of the upper parts lighter and more uniformly distributed; nose and postorbital region but slightly dusky; tuft of hair at base of ears light; hind foot smaller; skull smaller in most parts measured; anterolateral angle of parietal on dorsal side more acute; nasals more truncate posteriorly; main axis of frontopremaxillary suture more nearly transverse to long axis of skull; anterior palatine foramina with posterior end farther forward with respect to first upper molars; shelf of bony palate relatively longer. We know *attwateri* from Osgood's (1909:147) account and two adults from 3 miles north of Springer, Carter County, Oklahoma.

From *rowleyi,* as known to us by the specimens mentioned above, the animals from the Chisos Mountains differ as follows: lateral line narrower and more distinct; ankles not as dusky; worn pelage with less Cinnamon; tail more thinly haired; postpalatal length greater; maxillary tooth row shorter.

The tail is relatively longer and the ears shorter than in either the topotypes of *rowleyi* or *attwateri,* but they are more nearly as in *attwateri.*

Remarks.—The brush mouse was fairly common in the Chisos Mountains above 4700 feet. The specimens taken were from rocky areas covered with piñon, juniper, oak, and brush.

Peromyscus pectoralis laceianus Bailey

Encinal Mouse

Peromyscus pectoralis laceianus Bailey, Proc. Biol. Soc. Wash., 19:57, May 1, 1906.

Records of occurrence.—Specimens examined, 8: Field Museum nos. 46921–46924, 46926, 46927, 46931; Univ. Mich. 79176. These are distributed by localities as follows: Chisos Mountains, 5100 feet, 1; The Basin, 5108 feet, 7. Other record of occurrence: Chisos Mountains (Osgood, 1909:165).

Measurements.—Average of 5 adults: total length, 188 (182–202); tail vertebrae, 104 (95–113); hind foot, 21 (19–22); ear from notch dry, 15.8 (15–17); greatest length of skull, 27.6 (27.0–28.2); basilar length, 19.8 (18.6–21.0); zygomatic breadth, 13.5 (13.0–13.9); interorbital constriction, 4.5 (4.5–4.6); length of nasals, 10.3 (9.9–10.9); shelf of bony palate, 4.3 (4.2–4.6); palatine slits, 5.1 (4.9–5.2); diastema, 6.8 (6.4–7.0); postpalatal length, 9.3 (8.8–9.9); maxillary tooth row, 4.1 (4.0–4.3).

Comparisons.—These specimens are typical *P. p. laceianus,* as known to us by Osgood's (1909:164) description, both in external features and skull measurements. They can be distinguished from the other species of *Peromyscus* found in the Big Bend area by the white tarsal joint without dusky markings and by the smaller size of the tubercle on the outer surface of the mandible.

Sigmodon hispidus berlandieri Baird

Hispid Cotton Rat

Sigmodon berlandieri Baird, Proc. Acad. Nat. Sci. Phila., 1854–55:333, 1856.

Sigmodon hispidus berlandieri, Bailey, Proc. Biol. Soc. Wash., 15:106, June 2, 1902.

Specimens examined.—Four: nos. 80489–80491, from Big Bend of Rio Grande, 2000 feet; Univ. Mich. 79139, from Johnson Ranch, 2060 feet.

Measurements.—One adult female: total length, 274; tail vertebrae, 118; hind foot, 31; ear from notch dry, 15; basal length of skull, 29.1; length of nasals, 12.9; zygomatic breadth, 19.6; mastoidal breadth, 14.1; maxillary tooth row, 6.1.

Comparisons.—These specimens show no consistent differences from *S. h. berlandieri*, as known to us by Bailey's (1902:106) synopsis. The upper parts are uniformly buffy gray with the sides slightly lighter; the under parts and the feet are gray; the tail is blackish above and gray below and is thinly haired.

S. h. berlandieri may be distinguished from *S. ochrognathus* by the absence of ochraceous coloring on the nose and the sides of the body. The former lives at lower elevations in the vicinity of the Rio Grande, whereas the latter is found at higher elevations in the Chisos Mountains. A comparison of the skulls of the two forms reveals the following differences: in *ochrognathus* the first inner root of the first upper molar projects more medially, whereas the first root in *berlandieri* projects only slightly or not at all beyond the other roots; in the former the premaxillae extend posteriorly to the plane of the anterior ends of the supraorbital ridges, whereas in the latter they extend slightly or not at all back of the nasals; the nasals of *ochrognathus* gradually increase in width from the posterior to the anterior end, in contrast to the abrupt anterior widening of the nasals of *berlandieri*. *S. ochrognathus* may also be distinguished by the presence of a prominent point at the posterior margin of the bony palate, by the less inflated bullae, by the flattened dorsal surface of the skull, and by the concave surface of the nasals.

Remarks.—Hispid cotton rats were found only in the river bottom at the Johnson Ranch. Evidence of their presence, in the form of trails and cut vegetation, was frequently found among the cane, mesquite, and *Baccharis*. Elmo Johnson said that he had found them in his cultivated fields. No sign was found at Boquillas or on the Daniel Ranch, although conditions here appeared ideal. A female taken on April 16, 1937, contained four large embryos.

Sigmodon ochrognathus Bailey

Mountain Cotton Rat

Sigmodon ochrognathus Bailey, Proc. Biol. Soc. Wash., 15:115, June 2, 1902.

Records of occurrence.—Specimens examined, 17: nos. 80493–80504; skeletons only 74344, 74345; Univ. Mich. 79153–79155. These are distributed by localities as follows: Pine Canyon, 4700 feet, 7; Laguna Meadow, 6500 feet, 10. Other records of occurrence: Chisos Mountains (Bailey, 1902:115; Bailey, 1905:118).

Measurements.—Average of 7 adult males: total length, 249 (232–267); tail vertebrae, 110 (101–122); hind foot, 27.2 (26.0–29.2); ear from notch dry, 14.2 (13–15); basal length of skull, 28.3 (27.3–29.4); length of nasals, 11.8 (11.1–12.4); zygomatic breadth, 18.6 (17.7–19.5); mastoidal breadth, 14.1 (13.7–14.6); alveolar length of maxillary tooth row, 5.9 (5.8–6.0). Average of 3 adult females: total length, 255 (251–264); tail vertebrae, 112 (110–115); hind foot, 26.9 (25–28); ear from notch dry, 14.2 (14.0–14.5); basal length of skull, 27.9 (27.6–28.1); length of nasals, 11.4 (11.4–11.5); zygomatic breadth, 18.4 (18.0–18.6); mastoidal breadth, 14.0 (13.6–14.2); alveolar length of maxillary tooth row, 5.9.

Comparisons.—The type locality of *S. ochrognathus* is in the Chisos Mountains. As would be expected, the present series of animals is typical. The upper

parts are yellowish gray; the nose, orbital ring, and upper parts of the forelegs are bright ochraceous; the under parts are white tinged with buff; the feet are buffy gray; the tail is blackish above and buffy gray below. The specimens taken in November are slightly darker than those taken in May. The young resemble the adults in color but are darker above and are less ochraceous.

Remarks.—These cotton rats were plentiful in Laguna Meadow (pl. 4, *b*), which supports a good stand of needlegrass (*Stipa*), and evidence of their presence was observed in a few grassy places above this. Ten specimens were trapped at Laguna Meadow on November 1 and 2, 1936, two in a path through the center of the meadow, the remaining 8 under logs or brush piles near its edge or among the piñons and junipers 100 yards from the meadow. The number trapped indicated that the cotton rat was common here, although there was at the time but little evidence of its presence.

A scattered colony was found in Pine Canyon (pl. 5, *b*), living among short grama grass, sotol, and bear grass. Nests were found beneath the dead lower leaves of the sotol, and trails often led from one plant to another.

A large red racer (*Masticophis flagellum*) was caught in a rat trap which had been set in a runway of a cotton rat. Two large chicken snakes (*Elaphe bairdi*) and a striped racer (*Masticophis taeniatus*) were collected within the area occupied by cotton rats.

A long breeding season is indicated by the capture of a cotton rat, about one-third grown, in Pine Canyon on May 6, 1937, and two of similar size at Laguna Meadow on November 1, 1936.

Neotoma micropus canescens Allen

Baird Wood Rat

Neotoma micropus canescens Allen, Bull. Amer. Mus. Nat. Hist., 3:285, June 30, 1891.

Records of occurrence.—Specimens examined, 7: nos. 80510–80515; skeleton only 80507. These are distributed by localities as follows: E base of Burro Mesa, 3500 feet, 2; Glenn Spring, 2606 feet, 1; N end of Mariscal Mountain, 2300 feet, 2; Big Bend of Rio Grande, 2000 feet, 2. Other record of occurrence: Chisos Mountains (Goldman, 1910:29).

Measurements.—One adult male and two adult females: total length, 365, 340, 343; tail vertebrae, 155, 151, 144; hind foot, 38, 35, 35; ear from notch dry, 21, 21, 23; basilar length of skull, 39.0, 37.1, 37.4; zygomatic breadth, 25.9, 24.3, 24.0; interorbital constriction, 6.5, 5.7, 6.1; length of nasals, 17.3, 17.4, 17.6; length of incisive foramina, 10.0, 9.8, 9.9; shelf of bony palate, 8.1, 7.4, 7.8; alveolar length of maxillary tooth row, 8.6, 8.3, 8.6.

Comparisons.—These specimens closely resemble *N. m. canescens*, as known to us by animals from Lincoln and Socorro counties, New Mexico, and Hemphill County, Texas, and also by Goldman's (1910:28) revision. The upper parts are slightly lighter, with less rufous and more gray. The skulls are variable, particularly in the size and shape of the interpterygoid fossa, but there are no constant differences between the specimens from any two localities.

Remarks.—The Baird wood rat was not common but it was widely distributed from the river bottom up to 3500 feet elevation. Its houses, composed of sticks and pieces of cactus, were usually situated in mesquite, catclaw, or cactus, but a few were found in old dwellings and among rocks.

Neotoma albigula albigula Hartley

White-throated Wood Rat

Neotoma albigula Hartley, Proc. Calif. Acad. Sci., 4:157, May 9, 1894.

Specimens examined.—Five: nos. 80505, 80506, 80508, 80509; Field Museum 46919. These are distributed by localities as follows: Flat NE of Chisos Mountains, 3800 feet, 1; Green Gulch, 5200 feet, 1; The Basin, 5200 feet, 2; Oak Creek, 5000 feet, 1.

Measurements.—One adult male: total length, 320; tail vertebrae, 135; hind foot, 32; ear from notch dry, 23; basilar length of skull, 35.1; zygomatic breadth, 22.2; interorbital constriction, 5.9; length of nasals, 14.5; length of incisive foramina, 8.7; shelf of bony palate, 7.3; alveolar length of maxillary tooth row, 8.4.

Comparisons.—These animals differ from typical *N. a. albigula,* as known to us by specimens from Fort Lowell, Pima County, Arizona, and by Goldman's (1910:31) account, in the following features: upper parts darker; sides darker buff and with more blackish intermixture; cheeks less buffy; nasals relatively broader and more truncate posteriorly; premaxillae not extending as far back of nasals; interparietal more rectangular; interpterygoid fossa broader anteriorly; bony palate shorter; incisive foramina more nearly oval.

Although it is possible to separate the Chisos Mountains specimens from the Fort Lowell specimens on the basis of the differences described, study of animals from the intervening region does not reveal intergradation between the two. Specimens from Coconino and Navajo counties, Arizona, are intermediate in color and in the variable characteristics of the skull; those from Greenlee County, Arizona, more closely resemble the Chisos Mountains specimens; those from Graham County, Arizona, are similar to the Fort Lowell specimens in color but are more like the Chisos Mountains specimens in the features of the skull; specimens from the lava beds of Socorro and Dona Ana counties, New Mexico, are in general darker than either the Fort Lowell or the Chisos Mountains specimens, but among the specimens from New Mexico some are indistinguishable from the Fort Lowell specimens and others are similar to the Chisos Mountains specimens; those from Grant and Otero counties, New Mexico, are more like those from the Chisos Mountains in color and skull features; those from Chihuahua and Sonora, Mexico, show all gradations between the features of the Fort Lowell and the Chisos Mountains specimens. It is evident that *N. a. albigula* is subject to extensive variation in the different parts of its range and that the variations are sporadic.

Remarks.—Four specimens of the white-throated wood rat were obtained in the Chisos Mountains between 5000 and 5200 feet elevation. One was taken in heavy brush and the other three had their houses in or near *Agave lecheguilla,* upon which they were feeding.

Lepus californicus texianus Waterhouse

Black-tailed Jack Rabbit

Lepus texianus Waterhouse, Nat. Hist. Mamm., 2:136, 1848.
Lepus californicus texianus, Nelson, N. Amer. Fauna, 29:142, August 31, 1909.

Records of occurrence.—Specimens examined, 5: nos. 80516, 81693; skulls only 80517, 81694; Field Museum 46941. These are distributed by localities as follows: E base of Burro

Mesa, 3500 feet, 3; N end of Mariscal Mountain, 2300 feet, 1; Boquillas, 1. Other record of occurrence: Chisos Mountains (Nelson, 1909:145).

Measurements.—Average of 5 adult males: total length, 551 (520–570); tail vertebrae, 72 (68–77); hind foot, 128 (123–135); ear from notch dry, 135 (119–150); basilar length of skull, 75.6 (74.5–77.7); length of nasals, 41.6 (37.6–46.2); breadth of rostrum above premolars, 25.0 (24.3–25.9); depth of rostrum in front of premolars, 22.0 (20.8–23.4); parietal breadth, 27.6 (27.0–28.1); diameter of bullae, 14.7 (14.6–14.9).

Comparisons.—A comparison of these specimens with animals from San Juan County, Utah, and Otero and Hidalgo counties, New Mexico, shows them to be *L. c. texianus.* They differ from the above animals and from typical specimens, as known to us by Nelson's (1909:142) description, in the following features: the supraorbital processes are larger and stronger; the anterior extension of the frontals between the posterior parts of the nasals is more truncate; the bullae are slightly larger. The total length, the tail vertebrae, and the hind foot are shorter and the ears are longer.

The specimens show a decided change in pelage between spring and fall. Those taken in March and May have a mosaic of dark and gray colors in the upper parts, the dorsal surface of the tail and the central part of the rump are black, and the nape of neck is dark with a brown admixture. By fall the upper parts have become a uniform grayish brown with little dark showing, the tail and central part of the rump are dark brown dorsally, and the nape of the neck is light brown.

Remarks.—Black-tailed jack rabbits were fairly common from the Rio Grande to about 5000 feet elevation in the Chisos Mountains. They were most frequently seen in brushy areas between 2000 and 3500 feet elevation. A few were seen in the Dead Horse Mountains and at the bases of the Christmas and Rosillos Mountains. Two half-grown young were seen at Glenn Spring on October 22, 1937.

Sylvilagus robustus (Bailey)

Mountain Cottontail

Lepus pinetis robustus Bailey, N. Amer. Fauna, 25:159, October 24, 1905.
Sylvilagus robustus, Nelson, N. Amer. Fauna, 29:194, August 31, 1909.

Records of occurrence.—Specimen examined: One, no. 80518, from Oak Creek, 5000 feet. Other records of occurrence: Chisos Mountains (Bailey, 1905:160; Nelson, 1909:194).

Measurements.—One adult male: total length, 420; tail vertebrae, 50; hind foot, 90; ear from notch dry, 70; basilar length of skull, 55.6; length of nasals, 30.6; breadth of rostrum above premolars, 17.6; depth of rostrum in front of premolars, 15.9; parietal breadth, 25.4; diameter of bullae, 11.5.

Comparisons.—This specimen, taken on October 26, 1936, is in fresh winter pelage. It differs from *S. a. minor* in the following features: size larger; dark color of upper parts more concentrated medially; sides iron gray and in marked contrast with the color of upper parts; outer surfaces of legs bright cinnamon rufous; chin gray; patch of hair on underside of neck dark buffy gray; tail longer; bullae smaller and their surfaces smooth. *S. robustus* is resident primarily at higher elevations, whereas *S. a. minor* is usually found at lower altitudes.

Remarks.—These large cottontails were observed at several places in the

Chisos Mountains above 4700 feet elevation. Since they were scarce and stayed in heavy brush, they were not easily seen. They were more in evidence in the lower part of Pine Canyon (pl. 5, *b*) than in any other area visited. Here, on the afternoon of May 6, 1937, three were jumped from brush patches. Another was seen at 5500 feet in the same canyon on October 17, 1937. The lower part of the range of this species overlaps the upper range of *S. a. minor*. Both species were seen in the lower part of Pine Canyon at about 4700 feet. The highest elevation at which *S. robustus* was seen was about 6700 feet just above Laguna, on November 2, 1936.

Sylvilagus audubonii minor (Mearns)

Audubon Cottontail

Lepus arizonae minor Mearns, Proc. U. S. Nat. Mus., 18:557, June 24, 1896.
S[ylvilagus]. a[uduboni]. minor, Nelson, Proc. Biol. Soc. Wash., 20:83, July 22, 1907.

Records of occurrence.—Specimens examined, 5: nos. 80519, 80520, 81695; Field Museum 46944, 46945. These are distributed by localities as follows: Neville Spring, Grapevine Mountains, 3290 feet, 2; Chisos Mountains, 1; one mile E Nugent Pass, Chisos Mountains, 1; E base of Burro Mesa, 3500 feet, 1. Other record of occurrence: Chisos Mountains and Boquillas (Nelson, 1909:228).

Measurements.—Two adult males: total length, 330, 333; tail vertebrae, 31, 35; hind foot, 78, 77; ear from notch dry, 61, 64; basilar length of skull, 48.0, 49.9; length of nasals, 25.4, 27.4; breadth of rostrum above premolars, 15.9, 16.6; depth of rostrum in front of premolars, 14.0, 14.7; parietal breadth, 23.6, 23.7; diameter of bullae, 13.6, 13.5. Two adult females: total length, 335, 370; tail vertebrae, 40, 39; hind foot, 80, 80; ear from notch dry, 65, 62; basilar length of skull, 49.0, 51.3; length of nasals, 27.6, 26.1; breadth of rostrum above premolars, 14.3, 15.6; depth of rostrum in front of premolars, 14.1, 13.6; parietal breadth, 22.5, 22.1; diameter of bullae, 13.2, 13.6.

Comparisons.—In the Chisos Mountains area, *S. a. minor* may be confused with only *robustus,* from which it differs in a number of features, which are noted in the discussion of *robustus.* There is a possibility that *minor* may intergrade with *neomexicanus* in the district north of the Chisos Mountains, where we know their ranges are almost contiguous (see *S. a. neomexicanus*).

The molt appears to begin early in August and to continue until December. The upper parts of specimens beginning the molt are whitish gray with a buffy tinge, with pure buff showing in various places. Pelages of specimens taken in April are intermediate between the pale summer and dark winter pelages. In these specimens the sides are light colored but conspicuously buffy.

The skulls from the Chisos Mountains area are highly variable but do not differ constantly from specimens taken in Otero, Hidalgo, and Dona Ana counties, New Mexico.

Remarks.—The Audubon cottontail was common in suitable localities from the Rio Grande to about 4700 feet elevation in the Chisos Mountains. It favored thickets of mesquite, catclaw, cactus, and creosote, and was especially numerous in such habitats near water. It was common along the Rio Grande, along the east base of Burro Mesa, and about Glenn and Neville springs. Occasionally individuals were observed on the flats, but they were much less common in this environment. A few were seen in the Dead Horse Mountains and at the bases of the Christmas and Rosillos mountains.

Sylvilagus audubonii neomexicanus Nelson

Audubon Cottontail

Sylvilagus audubonii neomexicanus Nelson, Proc. Biol. Soc. Wash., 20:83, July 22, 1907.

Specimen examined.—One adult male, Univ. Mich. no. 79357, from 28 miles S of Alpine.

Measurements.—Total length, 356; tail vertebrae, 47; hind foot, 81; ear from notch dry, 61; basilar length of skull, 47.5; length of nasals, 25.2; breadth of rostrum above premolars, 14.0; depth of rostrum in front of premolars, 12.1; parietal breadth, 23.3; diameter of bullae, 12.3.

Comparisons.—*S. a. neomexicanus* differs from *S. a. minor* in the following features: upper parts more rusty; forelegs more rufous; feet relatively longer; frontal area of skull flatter; and bullae smaller. No evidence of intergradation is noted when our one specimen is compared with *S. a. minor* from only 30 miles to the south. The specimen available is from outside the proposed park boundary.

Pecari angulatus angulatus (Cope)

Javeline

D[icotyles]. angulatus Cope, Amer. Nat., 23:147, February, 1889.
Pecari angulatus angulatus, Miller, Bull. U. S. Nat. Mus., 79:383, December 31, 1912.

Specimens examined.—Three: nos., skin only 80521, from Neville Spring, 3290 feet; complete skeleton 80522, from Government Spring, 3900 feet; Field Museum skull only 46958, from Juniper Canyon, 6700 feet.

Measurements.—One young female: basal length of skull, 180; occipitonasal length, 207.5; zygomatic breadth, 94.5; palatal length, 110; greatest breadth across auditory bullae, 56.4; length of upper premolar–molar series, 65.0.

Comparisons.—Comparison of these specimens with *P. a. angulatus*, as known to us by a single skull from Rock Springs, Edwards County, Texas, and also by descriptions given by Cope (1889:147) and Mearns (1907:160), shows no essential differences either in color or in features of the skull.

The skin is that of a young female. The vertebral stripe has a distinct reddish color. The lighter colored bands of the bristles vary from yellowish to buff and are never white.

A young female skull has the following teeth of the permanent dentition: first and third lower incisors, first and second upper and lower molars. The first upper incisor is being replaced and the third upper and lower molars are coming in. Of the remaining teeth of the milk dentition, the upper and lower premolars show excessive wear.

Remarks.—In the Big Bend area this animal is called the javeline. Until recently the javeline was hunted at all times of the year, partly by professional hide-hunters, one of whom operated in the vicinity of Neville Spring as late as 1935.

For some reason not clear to us, javelines are confined to a comparatively small portion of the proposed park area, although many other parts appear to offer the same type of habitat. Their present range is confined to the slopes and flats surrounding the northern end of the Chisos Mountains from Rock Spring to Blue Creek between 3200 and 4000 feet elevation. On the flats their range extends from the base of the Chisos Mountains to Grapevine Hills and

Christmas Mountains. The largest herd ranges from Neville Spring and Paint Gap Hills to the base of the Chisos Mountains. A small herd ranges between Burro Mesa and the Chisos Mountains, another along Blue Creek, one in the vicinity of Rock Spring, and possibly one in the vicinity of Mule Ear Peaks. These localities support a good growth of catclaw, mesquite, sotol, creosote, persimmon, and prickly pear and other cacti. Occasionally javelines are seen along the main road in the vicinity of Lone Mountain. The highest elevation from which they were recorded was the vicinity of Laguna, where one was seen by W. B. McDougall, October 1, 1935, and fresh sign was seen by Borell at 6600 feet elevation on November 2, 1936. John Daniel lived at Laguna during 1917 and 1918 but saw no javelines while there.

Fresh sign was observed at the north end of Christmas Mountains, at 5000 feet, on November 5, 1936; at 5200 feet in Green Gulch on November 12 and 16, 1936; at Neville Spring on October 7, 1937; and along the east base of Burro Mesa, at 3500 feet, on April 10 and 11, 1937. In late August, 1936, Lloyd Wade and Ross Maxwell saw three sows and two small pigs in the road on the east side of Burro Mesa. One of the pigs was captured and later released. The senior author saw a single javeline, judged to be an old boar, at 3500 feet on the Strawhouse Trail in the Dead Horse Mountains on October 16, 1936. They are apparently scarce in these mountains, as no others were seen during a four-day saddle trip through the area.

We obtained no recent records of javelines on the south and east slopes of the Chisos Mountains, between Rock Spring and Mule Ear Peaks. Aaron Green said that as late as 1916 he had seen javelines along the base of the mountains south of Rock Spring as far as the mouth of Juniper Canyon. Delphy Walker saw a few javelines on Mariscal Mountain in 1927 and 1928 but knows of none there now. Lloyd Wade reported that he saw a few javelines near Indianola Peak (Elephant Tusk) about 1921 and that he had never heard of javelines in the higher parts of the Chisos Mountains prior to 1932 or 1933. He thought that drought had driven them into the mountains. H. M. Wilson reported having seen javelines in the vicinity of Mule Ear Peaks.

Drought and heavy grazing by domestic stock has greatly reduced forage and shelter and probably has been an important factor in reducing the range and number of javelines. Formerly there were extensive, dense thickets in many of the canyons and on some of the flats. Cattle have gradually beaten trails through these thickets, making it possible now for a person to walk or to ride a horse through all but a few areas. Domestic stock also eat and trample the prickly pear and other cacti on which the javelines depend in part for feed.

Until 1936, javelines in Texas were given no protection, but in that year the Texas Game, Fish, and Oyster Commission passed a law prohibiting the killing of these animals in the Big Bend area.

Odocoileus hemionus crooki (Mearns)

Mule Deer

Dorcelaphus crooki Mearns, Preliminary diagnoses of new mammals of the genera Mephitis, Dorcelaphus, and Dicotyles, from the Mexican border of the U. S., p. 2, February 11, 1897. [Preprint from Proc. U. S. Nat. Mus.]

Odocoileus hemionus crooki, Goldman and Kellogg, Jour. Mammal., 20:507, November 14, 1939.

Records of occurrence.—Specimen examined: One adult male, no. 80524, from Smoky Spring, 3800 feet. Other record of occurrence: Chisos Mountains (Bailey, 1905:65).

Measurements.—Skull: basilar length, 250; length of nasals, 85.2; greatest width of nasals, 32.2; least width of nasals, 23.0; width of external nares, 40.5; length of external nares, 72.0; elevation of rostrum, 61.8; orbital width, 86.0; zygomatic width, 124.0; mastoidal width, 92.2; palatal width, 51.0; postpalatal width, 32.0; upper molar series, 87.3; lower molar series, 94.0; diastema, 72.5. Antler (right side): corona to primary fork, 207; circumference one inch above corona, 104. Spread of antlers at primary forks, 369; greatest outside spread, 455; spread between tips of anterior prongs, 355.

Comparisons.—The color of this specimen agrees with that of *O. h. crooki* (until recently called *O. h. canus*) as known to us by Merriam's (1901:560) description. The skull is smaller in most measurements taken than that of *O. h. hemionus* (for measurements of the latter see Cowan, 1936:205). The upper and lower molar series measure 87.3 and 94.0 respectively, as compared with an average of 78.0 and 89.0 for *hemionus* from Modoc County, California. Also, the antlers are slenderer and the beam is shorter and more concave. These features are in agreement with *crooki.*

Remarks.—This deer is locally known by the name of blacktail. It ranges from about 2500 feet up to 5000 feet elevation, but is most abundant on the mesas and slopes between 3000 and 4000 feet. Between these elevations, grass, sotol, yucca, and several kinds of brush furnish food and shelter. The upper range of the mule deer overlaps the lower range of the white-tailed deer. The whitetail usually selects the rough, brushy habitats, whereas the mule deer favors more open areas, and its favorite habitat appears to be at the head of a draw which supports a good stand of sotol and grass.

The main population of mule deer is found in the lower foothills of the Chisos Mountains, but there are a few on Mesa de Anguila, in the Dead Horse Mountains, and in other detached hills and mesas. They often forage on the flats at night.

The mule deer is the most important game animal in the Big Bend area. Every season large numbers of hunters come to the Chisos Mountains and surrounding ranges. The mule deer remains fairly common throughout its range in spite of heavy hunting and heavy grazing of its range by domestic stock. Texas game laws authorize the land owner to charge for hunting privileges and give him authority to enforce trespass and game regulations. Since the deer are a financial asset, the ranchers make a sincere effort to protect them. One rancher stated that in some years his deer brought him a greater income than his cows. Forty hunters were on this ranch on the opening day of the 1936 season. The sum usually charged for hunting is from five to ten dollars per day.

Odocoileus virginianus carminis Goldman and Kellogg

White-tailed Deer

Odocoileus virginianus carminis Goldman and Kellogg, Proc. Biol. Soc. Wash., 53:81, June 28, 1940.

Records of occurrence.—Specimens examined, 4: nos. 80523, Field Museum skulls only 46955–46957. These are distributed by localities as follows: near Moss Well, 5400 feet, 1;

Chisos Mountains, 2; The Basin, 5700 feet, 1. Other record of occurrence: Chisos Mountains (Bailey, 1905:64).

Measurements.—Skulls of one adult male and one adult female: basilar length, 223, 209; length of nasals, 68, 64; greatest width of nasals, 32, 30; least width of nasals, 23, 18; orbital breadth, 66, 61; zygomatic breadth, 108, —; mastoidal breadth, 83, 67; elevation of rostrum, 39, 37; width of external nares, 34, 25; length of external nares, 63, 57; palatal breadth, 46, 40; postpalatal breadth, 26, 23; upper molar series, 71, 69; lower molar series, 75, 76; diastema, 69, 57. Right antler of male whose cranial measurements are given above: corona to primary fork, 100; primary fork to second fork, 106; second fork to third fork, 109; length of first prong, 87; length of second prong, 175; length of third prong, 76; length of fourth prong, 64; circumference of beam one inch above corona, 87; distance between primary forks, 150; greatest outside spread, 344.

Comparisons.—*O. v. carminis* may be distinguished from all other deer in Texas by its small size, relatively longer ears, and pale color. Skulls of immature animals are similar to comparable skulls of *O. v. texanus*, but the differences between the two become progressively more pronounced with age. The skull of *texanus* remains slender throughout life, whereas that of *carminis* becomes relatively broader and more massive, particularly in the rostral region.

The antlers of a "spike buck" measure 101 mm. and 96 mm. In this specimen the permanent dentition is present with the exception of the last molars. The last upper molar is partly free from the alveolus but the last lower molar still lies entirely within the dentary bone. In a slightly older buck the right antler is 112 mm. long and has a subbasal snag directed forward and medially. The last molars are almost full height.

Remarks.—White-tailed deer or flagtail are plentiful throughout the Chisos Mountains above 4500 feet elevation. They occasionally range down to 3500 feet elevation and are found on Burro Mesa, Chilicotal, and other hills and mesas. They favor the canyons and steep slopes of the Upper Sonoran and Transition life zones where junipers, piñons, several species of oaks, and brush afford dense shelter. Whitetails were frequently seen in Green Gulch, in the Basin (pl. 3, *a*), along Oak Creek, and in Pine Canyon. Tracks indicated that they were common about Laguna and in Juniper Canyon. The senior author saw a group of five does, four fawns, and two bucks above Smoky Spring on November 22, 1936, at about 4500 feet elevation. From one to five deer were usually seen on early morning trips down Oak Creek Canyon. Tarleton Smith (MS.) found a fawn about two days old on August 8, 1936, and saw at least 30 white-tailed deer in Pine Canyon in five days in the last week of July, 1936.

Although the white-tailed deer are important game animals, their numbers in the Chisos Mountains have not been appreciably affected by hunters. The dense cover inhabited by these deer makes hunting them difficult. The number of local hunters is small, and hunters from other regions usually concentrate their efforts on the mule deer. Also, the ranchers have discouraged hunting in the higher parts of the Chisos Mountains. Probably fewer than 10 whitetails are killed here each hunting season.

Heavy grazing by cattle, sheep, and goats seems to have a detrimental effect on the white-tailed deer, but apparently there is still enough forage and cover to maintain a good deer population. Most deer were in excellent condition.

Antilocapra americana subsp.

Antelope

Numerous reports from early residents of the Big Bend area indicate that antelope formerly ranged over much of the country west and north of the park, but that they were never common within the area. There are indications that a small herd frequented Tabosa Flat, just west of Mariscal Mountain, and that a few occasionally came into the district between Terlingua and Lajitas and possibly between the Rosillos Mountains and Persimmon Gap.

Thomas J. Miller, who has been in the Big Bend area for 37 years, and John Daniel stated that in the early days antelope were in Green Valley, which is northwest of the Christmas Mountains, but that they had never seen any within the proposed park area. Macario Hinojos occasionally saw a few antelope between Lajitas and Terlingua prior to 1912. Aaron Green, who has lived in the park region for 25 years, had never seen antelope nearer than Alpine but had heard that they once ranged farther south. Bailey (1905 :67) states: "In 1901 a bunch of about a dozen antelope was reported near Bone Spring." Delphy Walker saw from 30 to 50 antelope on Tabosa Flat between 1907 and 1911. He left the area in 1911 and the antelope were gone when he returned in 1927. Sam Nail stated that there were a few antelope on Tabosa Flat until about 1917. Harvey Pettit saw antelope on Tabosa Flat between 1918 and 1920.

The great difference of opinion among the early settlers makes it difficult to determine the former status of the antelope in the Big Bend area. However, it must be remembered that until recently the only means of travel in the area was by horse or wagon, so that it would possible for a small herd of antelope to frequent the area and seldom be seen. The number of reliable residents who state that they personally saw antelope on Tabosa Flat is convincing evidence that antelope formerly inhabited this region and that a few may have remained as late as 1920.

The lower country in the park area has been severely overgrazed and is not now suitable for the introduction of antelope. If the vegetation were restored, Tabosa Flat and the section between the Chisos Mountains and Persimmon Gap probably would support a large number of antelope.

Ovis canadensis texiana Bailey

Bighorn

Ovis canadensis texianus Bailey, Proc. Biol. Soc. Wash., 25:109, June 29, 1912.

Specimen examined.—One horn, no. 80525, picked up on Mariscal Mountain.

Comparisons.—The horn found on Mariscal Mountain is badly crumpled and has been subjected to weathering for many years. It measures about 550 millimeters along the outer curve and is 200 millimeters in circumference at a distance of 250 millimeters from the outer tip.

There is some doubt whether the bighorn sheep formerly in the Chisos Mountains area are referable to *O. c. texiana* or to *O. mexicana*. Bailey (1905 :70)

referred them, along with animals from the Guadalupe Mountains, to *mexicana*. He later described *texiana* from the Guadalupe Mountains but does not mention the bighorn of the Chisos Mountains. He makes the following statement in his discussion of *texiana* (1931:18): "The steep southwestern slope of the Sacramento Mountains is also ideal sheep country, and it is highly probable that in the early days this desert-loving sheep practically surrounded the Tularosa Valley and in Texas extended almost continuously to the Chisos Mountains." On this basis, and also because of geographic considerations, the bighorns of the Chisos Mountains area are probably referable to *texiana*.

Remarks.—The bighorn is now gone from the area of the park but its earlier presence is attested by remains and also by accounts obtained from early settlers. A number of residents reported that prior to 1900 they had heard of mountain sheep at four places: Mesa de Anguila, Marsical Mountain, Boquillas Canyon, and Nine Point Mesa. The last mentioned place is outside the proposed park boundaries. None of the early residents knew of any sheep living within the area since 1903. Bighorns apparently did not occur in the Chisos Mountains. All records obtained were from localities surrounding these mountains and along the Rio Grande.

Thomas J. Miller saw two rams that had been killed on Mariscal Mountain in 1903 by Tom Golby. Elmo Johnson donated a much weathered horn shell which one of his riders had picked up on Mariscal Mountain in the spring of 1936. Delphy Walker had not heard of any bighorns in the area since his arrival in 1907 but had since seen old horns on Mariscal Mountain. Macario Hinojos, who came to Lajitas in 1900, had not seen or heard of living mountain sheep in the area but had found a few old horns on Mesa de Anguila since that time. R. A. Serna stated that a bighorn was killed about 1907 on Nine Point Mesa. The head of a bighorn ewe killed 5 miles west of Alpine, Texas, in the fall of 1924, is in the Sul Ross College collection. A record attached to the skull indicates that two ewes were seen and that both were killed within a few days after their appearance.

J. O. Langford, the postmaster at Hot Springs, has a large set of horns which were picked up in the Music Mountains of Mexico, about 40 miles south of Hot Springs, in the fall of 1935. Measurements in inches of the circumference at base, and the length along the outside curve of the left and right horns, were as follows: 14.0, 14.5; 34.5, 33.5. The spread was 23 inches.

The information obtained indicates that mountain sheep were never common in the area and that they disappeared shortly after the first white settlers came. The former range of the bighorn has been heavily grazed by domestic sheep and goats. If the native subspecies could be obtained for restocking and if grazing should cease, it is probable that Mesa de Anguila, Mariscal Mountain, and Boquillas Canyon would again support mountain sheep.

MAMMALIAN FAUNA IN RELATION TO LIFE ZONES

The river bottom and desert flat associations are included in the Lower Sonoran life zone, which extends roughly from the Rio Grande to 4500 feet elevation. The upper limit of the zone varies in accordance with topography, direction

of slope, and insolation, but the variation is slight. There is a transition from the Lower to the Upper Sonoran zone in the lower foothill association, but the association is for the most part Lower Sonoran in character. In the Chisos Mountains most of the area above 4500 feet elevation is in the Upper Sonoran life zone. In limited places in Pine Canyon and Juniper Canyon and about Emory Peak there are indications of the Transition life zone, but these are so small that they have but little effect upon the fauna of the region.

The following tabulation of the mammals of the Big Bend area in relation to the life zones is based upon records of occurrence, as provided by specimens collected and by observations of animals in the field. We do not imply that all of the forms listed as restricted to a certain life zone are so limited in other areas. More information about the distribution of the mammals may show that some of the species have a wider zonal range in the Big Bend area than is indicated here.

RESTRICTED TO THE LOWER SONORAN LIFE ZONE

Didelphis mesamericana texensis
Notiosorex crawfordi crawfordi
Myotis californicus californicus
Lasiurus cinereus
Procyon lotor mexicanus
Taxidea taxus berlandieri
Canis lupus monstrabilis
Citellus spilosoma major
Cratogeomys castanops lacrimalis
Perognathus merriami gilvus
Perognathus penicillatus eremicus
Dipodomys merriami ambiguus
Dipodomys ordii attenuatus
Castor canadensis mexicanus
Onychomys torridus torridus
Reithrodontomys fulvescens canus
Peromyscus eremicus eremicus
Peromyscus leucopus texanus
Sigmodon hispidus berlandieri
Neotoma micropus canescens
Antilocapra americana

RESTRICTED TO THE UPPER SONORAN LIFE ZONE

Leptonycteris nivalis
Tadarida macrotis
Peromyscus boylii rowleyi
Peromyscus pectoralis laceianus
Sigmodon ochrognathus
Sylvilagus robustus
Odocoileus virginianus carminis

PRESENT IN BOTH LOWER AND UPPER SONORAN LIFE ZONE

Myotis yumanensis yumanensis
Myotis thysanodes thysanodes
Pipistrellus hesperus maximus
Eptesicus fuscus pallidus
Corynorhinus rafinesquii pallescens
Antrozous pallidus pallidus
Tadarida mexicana
Ursus americanus amblyceps
(mainly Upper Sonoran)
Bassariscus astutus flavus
Spilogale leucoparia
Mephitis mephitis varians
Conepatus mesoleucus mearnsi
Urocyon cinereoargenteus scottii
Canis latrans texensis
Felis concolor stanleyana
(mainly Upper Sonoran)
Lynx rufus baileyi
Citellus variegatus couchii
Citellus interpres
Thomomys bottae limitaris
Perognathus nelsoni canescens
Peromyscus maniculatus blandus
Neotoma albigula albigula
(mainly Upper Sonoran)
Lepus californicus texianus
(mainly Lower Sonoran)
Sylvilagus audubonii minor
Pecari angulatus angulatus
Odocoileus hemionus crooki
(mainly Lower Sonoran)
Ovis canadensis texiana

GEOGRAPHIC AFFINITIES OF THE MAMMALIAN FAUNA

The following lists of species, grouped according to their present distributional limits, show the geographic affinities of the mammalian fauna of the Big Bend area. Since all the species, with two possible exceptions, occur at least in northern Mexico, only the distributions of the species north of Mexico are given.

Limited to Western Texas, New Mexico, and Southeastern Arizona

Spilogale leucoparia
Conepatus mesoleucus (reaches southern Colorado)
Citellus interpres
Perognathus merriami
Perognathus nelsoni
Peromyscus pectoralis
Sigmodon ochrognathus
Sylvilagus robustus
Pecari angulatus

Ranging Widely in Southwestern United States

Notiosorex crawfordi
Pipistrellus hesperus
Antrozous pallidus
Tadarida macrotis
Bassariscus astutus
Citellus variegatus
Perognathus penicillatus
Dipodomys merriami
Onychomys torridus
Peromyscus eremicus
Neotoma albigula

Ranging Through Southwestern United States and Northward to Canada

Myotis yumanensis
Myotis californicus
Myotis thysanodes
Tadarida mexicana
Odocoileus hemionus
Ovis canadensis
Antilocapra americana

Occurring in Southwestern United States and Great Plains

Citellus spilosoma
Cratogeomys castanops
Reithrodontomys fulvescens
Neotoma micropus

Occurring in the United States from Great Plains Westward

Thomomys bottae
Dipodomys ordii
Peromyscus boylii (east to Missouri)
Lepus californicus
Sylvilagus audubonii

Widely Distributed in the United States

Eptesicus fuscus
Corynorhinus rafinesquii
Lasiurus cinereus
Ursus americanus
Procyon lotor
Mephitis mephitis
Taxidea taxus
Urocyon cinereoargenteus
Canis latrans
Canis lupus
Lynx rufus
Felis concolor
Castor canadensis
Peromyscus maniculatus
Peromyscus leucopus
Sigmodon hispidus
Odocoileus virginianus

Related to Forms Occurring in Eastern Mexico and Southern Texas

Didelphis mesamericana

SUMMARY

There are 55 species of mammals known from the Big Bend area. The biotic relationships of each of these has been indicated. A study of the geographic variation has been made of 49 of the species in the region of the Chisos Mountains.

There are four distinct biotic associations in the area: river bottom, desert flat, lower foothill, and Chisos Mountains proper. The Lower Sonoran life zone extends from the Rio Grande to the upper part of the lower foothill association. The Upper Sonoran life zone extends from this level to the top of the mountains. Spots of the Transition life zone occur in the Chisos Mountains. Twenty-one species of mammals are known from only the Lower Sonoran life zone, and 7 species from only the Upper Sonoran life zone.

The mammalian fauna of the Big Bend area consists mainly of species endemic to the southwestern United States and northern Mexico. Lesser relationships with the mammalian faunas of southern Mexico, the eastern United States, the Great Plains, and the western United States are indicated.

The Rio Grande is not a significant barrier to mammalian dispersal.

Transmitted November 8, 1940.

LITERATURE CITED

ALLEN, G. M.

1916. Bats of the genus Corynorhinus. Bull. Mus. Comp. Zoöl., 60:333–356, 1 pl., April, 1916.

1933. Geographic variation in the big brown bat. Can. Field Nat., 47:31–32, February, 1933.

BAILEY, V.

1902. Synopsis of the North American species of Sigmodon. Proc. Biol. Soc. Wash., 15:101–116, June 2, 1902.

1905. Biological survey of Texas. N. Amer. Fauna, 25:1–222, 16 pls. and 24 figs. in text, October 24, 1905.

1912. A new subspecies of mountain sheep from western Texas and southeastern New Mexico. Proc. Biol. Soc. Wash., 25:109–110, June 29, 1912.

1913. Two new subspecies of North American beavers. Proc. Biol. Soc. Wash., 26:191–193, October 23, 1913.

1915. Revision of the pocket gophers of the genus Thomomys. N. Amer. Fauna, 39:1–136, 8 pls., 10 figs. in text, November 15, 1915.

1931. Mammals of New Mexico. N. Amer. Fauna, 53:1–412, 22 pls. and 58 figs. in text, December, 1931.

BLAIR, W. F.

1938. Two new pocket-mice from western Texas. Occas. Papers Mus. Zoöl. Univ. Mich., 381:1–3, June 20, 1938.

BORELL, A. E.

1937. A new method of collecting bats. Jour. Mammal., 18:478–480, November 14, 1937.

1939. A colony of rare free-tailed bats. Jour. Mammal., 20:65–68, February 14, 1939.

COPE, E. D.

1889. On the Mammalia obtained by the Naturalist Exploring Expedition to southern Brazil. Amer. Nat., 23:128–150, January, 1889.

COWAN, I. M.

1936. Distribution and variation in deer (genus Odocoileus) of the Pacific coastal region of North America. Calif. Fish and Game, 22:155–246, 13 figs. in text, July, 1936.

ENGELS, W. L.

1936. Distribution of races of the brown bat (Eptesicus) in western North America. Amer. Mid. Nat., 17:653–660, 1 fig., May, 1936.

GOLDMAN, E. A.

1910. Revision of the wood rats of the genus Neotoma. N. Amer. Fauna, 31:1–124, 8 pls., 14 figs. in text, October 19, 1910.

1936. A new puma from Texas. Proc. Biol. Soc. Wash., 49:137–138, August 22, 1936.

1936a. New pocket gophers of the genus Thomomys. Jour. Wash. Acad. Sci., 26:111–120, March 15, 1936.

HALL, E. R.

1927. Species of the mammalian subfamily Bassariscinae. Univ. Calif. Publ., Bull. Dept. Geol. Sci., 16:435–448, 1 pl., 2 figs. in text, March 17, 1927.

HATFIELD, D. M.

1936. A revision of the Pipistrellus hesperus group of bats. Jour. Mammal., 17:257–262, 1 fig., August 14, 1936.

HOLLISTER, N.

1914. A systematic account of the grasshopper mice. Proc. U. S. Nat. Mus., 47:427–489, 1 pl., 3 figs. in text, October 29, 1914.

HOWELL, A. H.

1901. Revision of the skunks of the genus Chincha. N. Amer. Fauna, 20:1–62, 8 pls., August 31, 1901.

1914. Revision of the American harvest mice (genus Reithrodontomys). N. Amer. Fauna, 36:1–97, 7 pls., 6 figs. in text, June 5, 1914.

1938. Revision of the North American ground squirrels, with a classification of the North American Sciuridae. N. Amer. Fauna, 56:1–256, 32 pls., 20 figs. in text, April, 1938.

MEARNS, E. A.

1907. Mammals of the Mexican boundary of the United States. Bull. U. S. Nat. Mus., 56: 1–530, 13 pls. and 126 figs. in text, April 13, 1907.

MERRIAM, C. H.

1901. Seven new mammals from Mexico, including a new genus of rodents. Proc. Wash. Acad. Sci., 3:559–563, November 29, 1901.

1902. Six new skunks of the genus Conepatus. Proc. Biol. Soc. Wash., 15:161–165, August 6, 1902.

MILLER, G. S., JR.

1897. Revision of the North American bats of the family Vespertilionidae. N. Amer. Fauna, 13:1–140, 3 pls., 40 figs. in text, October 16, 1897.

MILLER, G. S., JR., and ALLEN, G. M.

1928. The American bats of the genera Myotis and Pizonyx. Bull. U. S. Nat. Mus., 144:i–viii, 1–218, 13 maps, 1 pl. with 15 figs., 1 fig. in text, May 25, 1928.

NELSON, E. W.

1909. The rabbits of North America. N. Amer. Fauna, 29:1–314, 13 pls., 19 figs. in text, August 31, 1909.

NELSON, E. W., and GOLDMAN, E. A.

1934. Revision of the pocket gophers of the genus Cratogeomys. Proc. Biol. Soc. Wash., 47:135–154, June 13, 1934.

OSGOOD, W. H.

1900. Revision of the pocket mice of the genus Perognathus. N. Amer. Fauna, 18:1–72, 4 pls., 15 figs. in text, September 20, 1900.

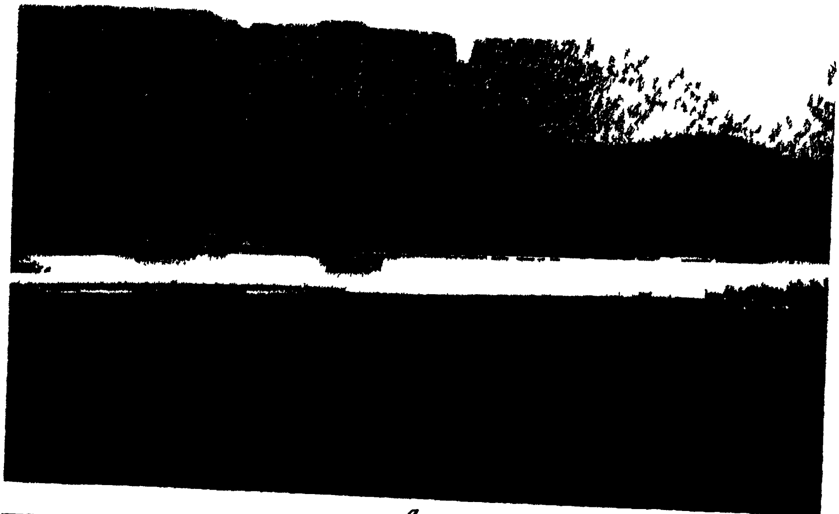
1909. Revision of the mice of the genus Peromyscus. N. Amer. Fauna, 28:1–285, 8 pls., 12 figs. in text, April 17, 1909.

PLATES

PLATE 1

a. Typical vegetation along the Rio Grande, near Castolon; Mesa de Anguila in background; elevation about 2100 feet. Photograph by George A. Grant, Department of the Interior, March 14, 1936.

b. Mouth of Santa Helena Canyon; Mexico on the left, Texas on the right; elevation 2146 feet. Photograph by George A. Grant.



a

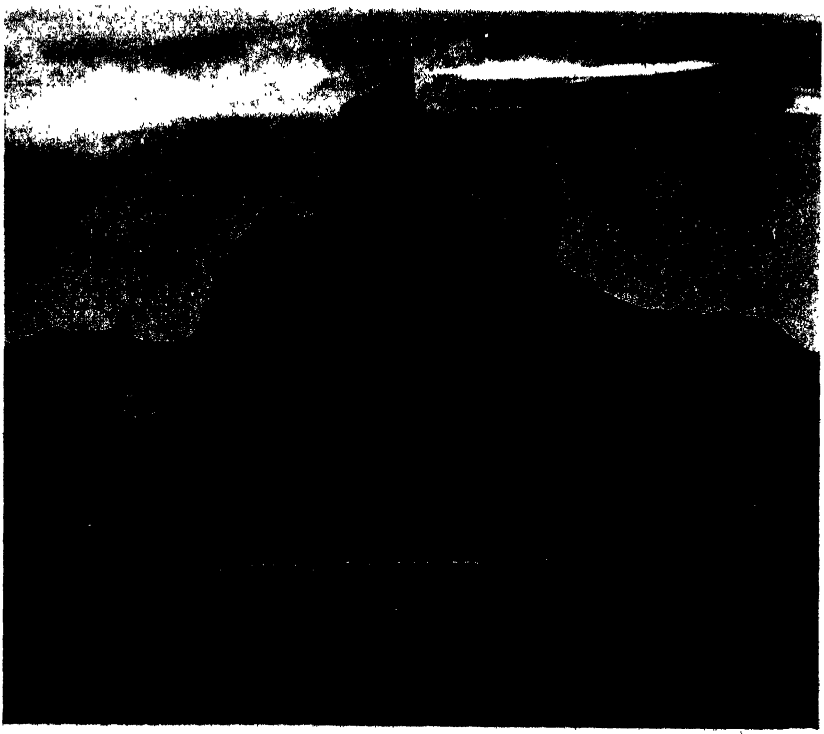
b

PLATE 2

a. Agave lecheguilla, home of the Botta pocket gopher, which eats the roots. Photograph by Adrey E. Borell.

b. Mule Ear Peaks, with typical desert vegetation in foreground. Photograph by George A. Grant, March 15, 1936.

a



b

PLATE 3

a. Tame white-tailed deer fawn in The Basin; elevation about 5400 feet. Photograph by Adrey E. Borell, October 24, 1936.

b. The Basin, with Pulliam Bluff in background. Photograph by Adrey E. Borell, November 2, 1936.

a

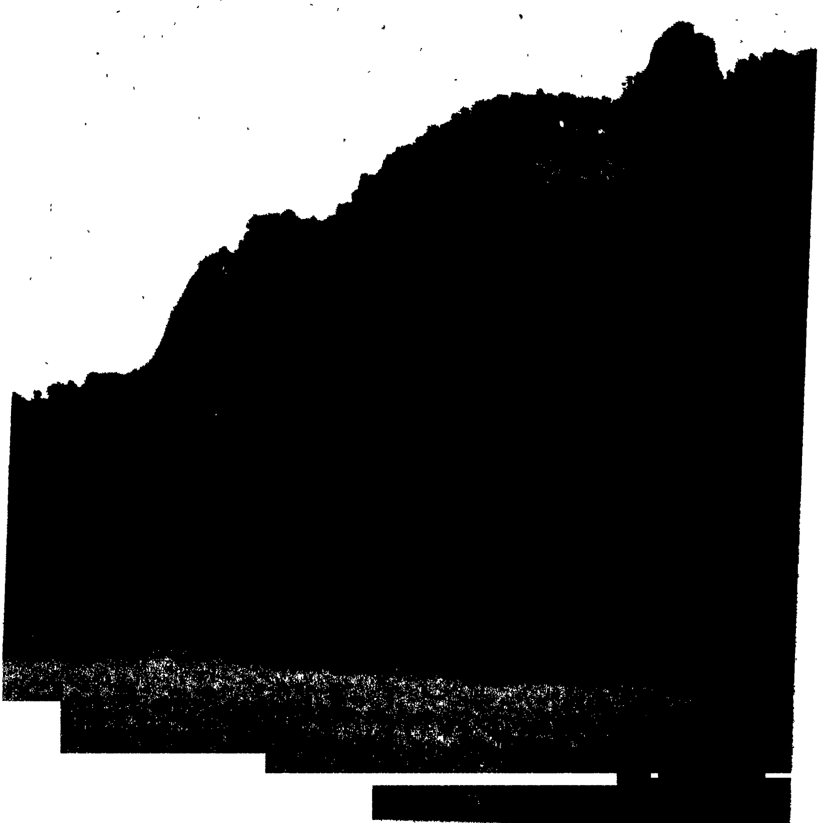
b

PLATE 4

a. Creosote and ocotillo, a common habitat which supports but little animal life.

b. Emory Peak, the highest peak within the area, with Laguna Meadow in foreground. This meadow of needle grass is the type locality of *Sigmodon ochrognathus*. Piñons and junipers border the meadow. Photograph by Adrey E. Borell, July 17, 1935.

a



b

PLATE 5

a. Vegetation in the upper part of Pine Canyon; elevation about 5700 feet. Photograph by C. N. Gould.

b. View in lower part of Pine Canyon. The large plants are bear grass and sotol. Photograph by Adrey E. Borell, May 8, 1937.

a

b

SYSTEMATIC REVIEW OF THE CHIPMUNKS (GENUS EUTAMIAS) OF CALIFORNIA

BY

DAVID H. JOHNSON

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1943

University of California Publications in Zoölogy
Editors (Berkeley): J. F. Daniel, E. R. Hall, Harold Kirby, S. F. Light
Volume 48, No. 2, pp 63–148, plate 6, 12 figures in text
Submitted by editors September 4, 1941
Issued December 24, 1943
Price, $1.00

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

SYSTEMATIC REVIEW OF THE CHIPMUNKS (GENUS EUTAMIAS) OF CALIFORNIA

BY

DAVID H. JOHNSON

(Contribution from the Museum of Vertebrate Zoölogy of the University of California)

INTRODUCTION

THE MANY KINDS of chipmunks of the genus *Eutamias* that live in California, with their respective adaptations in structure and activity to the varied environmental conditions occurring there, provide interesting problems of taxonomy, distribution, variation, natural history, and ecology. In the account that follows, some of these problems are presented and discussed through the medium of a review of the systematic status and distribution of the species and subspecies, taking into account the relations of the various kinds of chipmunks to the environments they inhabit.

The area included in the state of California is exceptionally favorable for a study of this sort. The characteristic local features, such as the Sierra Nevada and the coastal chaparral areas, are reflected in the presence of certain species of chipmunks not found elsewhere. The boundaries of the state extend far enough beyond these areas to include parts of the other important faunal regions of the Pacific slope and the Great Basin, together with their characteristic kinds of chipmunks. These circumstances result in a greater concentration of chipmunk species than in any other part of the range of the genus *Eutamias*. By the present conservative treatment there are ten full species of chipmunks in California, and the total number of named forms, including subspecies, is twenty-one. These include representatives of each of the five main groups into which Howell (1929:29–30) divides the American forms of *Eutamias*.

Topographic and climatic factors interact in California to produce a broad range of environmental conditions in a relatively small area. In terms of Merriam's life-zones, Boreal conditions extend far southward in the high mountains, and Sonoran or Austral conditions extend northward in the low valleys. The resulting concentration of life-zones as narrow strata along the eastern and western slopes of the mountains brings the ranges of several species of chipmunks into close proximity.

Within each widely ranging chipmunk species in the state there is appreciable geographic variation in the shade of coat color; coastal populations tend to be darker than interior ones. This variation forms the chief basis for designation of subspecies. It is closely correlated with the transition from coastal humid to interior arid conditions resulting from the interception of moisture-bearing winds from the ocean by the high mountain ranges.

Each species has a characteristic habitat which differs from those of other species. Where two or more species occur together in a general locality they are usually mutually exclusive in their choice of foraging and nesting sites and in the time of breeding.

MATERIALS AND ACKNOWLEDGMENTS

Most of the 3389 specimens of Recent *Eutamias* from California examined in the present study are in the collection of the Museum of Vertebrate Zoölogy at the University of California. Specimens have been borrowed for study from the California Academy of Sciences, the United States Biological Surveys Collection, the United States National Museum, and from the private collections of Jack C. von Bloeker, William B. Richardson, Oscar P. Silliman, Ralph Ellis, and Donald V. Hemphill. To the owners and persons in charge of these collections I am grateful for the courtesies they have extended.

The study was begun and partly completed under the supervision of the late Dr. Joseph Grinnell, whose stimulating counsel and example played a major part in shaping the ultimate form of the report. To his thoughtful management I am also indebted for many opportunities to carry on field work in various parts of California at intervals over a period of four years. Doctors E. Raymond Hall and Seth B. Benson have been especially helpful in the later stages of the work, and my sincere thanks are extended to them for their advice and assistance.

HISTORICAL SUMMARY

If the type specimen of *Tamias hindsii* Gray was collected in California, the first chipmunk specimen from the state to be preserved for scientific study was taken in 1837, and the first scientific account of the presence of chipmunks there was that published by Gray in 1842. However, as is discussed in detail elsewhere in this report, this specimen may have been collected near the mouth of the Columbia River, in which event Baird's account of the mammals of North America in the Pacific Railroad reports, published in 1857, contains the first technical treatment of Californian chipmunks. Four specimens were available to Baird, one collected by Dr. J. F. Hammond in the vicinity of Fort Reading, Shasta County, and three collected by E. Samuels in the redwoods north of Petaluma, Sonoma County. He referred them all to *Tamias townsendii* Bachman, Gray's *hindsii* being considered a synonym of that species. The Sonoma County specimens received special comment because of their unusually dark color and distinctively rusty brown underparts, but they were not recognized as distinct by name.

Ten years later, in 1867, Gray published a synopsis of the three species of "*Tamias*" then in the British Museum, one of which was *Tamias quadrimaculatus*, a new species from Michigan Bluff, Placer County. The two others, *hindsii* and *townsendii*, were both recorded from California. Gray apparently referred specimens with more whitish, better-defined light dorsal stripes to *hindsii* and those with more obscure stripes to *townsendii*, thus including under the former species specimens from the Cascades and British Columbia, which probably belong to the modern subspecies *cooperi*.

Of particular historical interest, in that it provides the first known list of restrictedly Californian mammals, is the chapter on zoölogy by James G. Cooper (1868) in Cronise's "Natural Wealth of California." Two species of chipmunks are included: *Tamias townsendii* from the Sierra Nevada and the

Coast Ranges as far south as Santa Cruz, and *Tamias quadrivittatus* from the high Sierra Nevada.

The work of J. A. Allen dominated the field during the three decades following 1870. In 1874 he published a list of North American squirrels in which all Californian chipmunks were referred to "*Tamias quadrivitatus* var. *Townsendi*," with Gray's *hindsii* and *quadrimaculatus* as synonyms. This extremely conservative treatment was in keeping with the belief, current among mammalogists of that period, that the collections then extant were adequate to indicate the principal trends of variation among North American mammals. Allen was deeply interested in correlating variations in characters of the animals, such as color and size, with the differences in the environmental conditions under which they live. He was one of the pioneers in the work which led to the formation of various "laws" of geographic variation, such as Bergmann's, Allen's, and Gloger's. The small number and poor quality of the specimens available to Allen, together with his tendency in this period to ignore cranial characters, and his enthusiasm for interpreting variations in size and color as graded responses to climatic conditions, led him to put all the previously named species of chipmunks from western North America under the one species, "*quadrivitatus*," and to recognize the obviously different forms as varieties.

Unable by his criteria to detect differences of specific value between the chipmunks of western North America and those of Asia, Allen, in his monograph of 1877, included both under the species *Tamias asiaticus*. Of Californian specimens, he listed those studied twenty years earlier by Baird from Sonoma County and Fort Reading, together with one from Fort Crook, Shasta County, under the variety "*townsendi*." Two others from Fort Crook were said to be "intermediate between vars. *borealis, quadrivittatus,* and *townsendi*," and still another from Fort Crook, along with specimens collected by John Xantus from the vicinity of Fort Tejon, Kern County, was listed as "intermediate between vars. *quadrivittatus* and *pallidus*." What Allen then considered a single variable species has since come to be regarded as a full genus, and his "varieties" correspond roughly to the modern species.

In 1886 C. Hart Merriam published the first of his long series of papers dealing with western chipmunks, at which time he named "*Tamias macrorhabdotes*" from Blue Canyon, Placer County. In 1887 Charles H. Townsend's account of the mammals he had collected and observed in Humboldt, Siskiyou, Shasta, and Lassen counties appeared. It contained several important records of chipmunks.

At or near this time Merriam was initiating the field work of the Division of Ornithology and Mammalogy, later to become the Bureau of Biological Survey, of the United States Department of Agriculture. Whereas previous collections of mammals had been made more or less fortuitously or had been bought from private collectors, Merriam's field parties worked methodically over the greater part of North America. From this well-directed collecting systematists became aware of the surprising variety of mammalian forms inhabiting the western part of the continent. There began an era of "splitting," in which hundreds of new kinds of mammals, most of which, in the

absence of intermediate specimens from the intervening areas, were described as full species.

Allen's later treatment of Californian chipmunks reflected this tendency. In 1889 he published the description of *merriami* and granted subspecific status to *hindsii*. In the following year (1890) he issued the first revision of western chipmunks that is now of more than historical interest. It was based largely on the collections brought together by Merriam, and it contained the original descriptions of four new species and recognized the validity of four previously named forms. In 1895 Allen described *pricei* from the Santa Cruz Mountains.

Merriam's revision of 1897 treated, directly or indirectly, all the Californian chipmunks. This work was principally the outcome of the Death Valley Expedition. Its appearance was followed by a quiescent period which extended over almost twenty years. In 1915 Grinnell named *sonomae*, and in 1916, in collaboration with Storer, *monoensis*, *mariposae*, and *kernensis*.

Soon thereafter, A. H. Howell began his extensive work on all the North American chipmunks, culminating in his revision of 1929, which is now the standard work on American forms of *Eutamias*. The only systematic work on Californian forms published since Howell's revision is the description of the race *scrutator* by Hall and Hatfield in 1934.

GENERAL CHARACTERS OF CHIPMUNKS

Chipmunks are the smallest squirrels in California. The head and body length of adults varies between 105 and 150 mm.; the greatest length of the skull, between 29 and 40 mm.; the weight of adult males, between 34 and 90 grams.

The body is slender, resembling that of the tree squirrels more than that of the ground squirrels. The head is longer and more pointed than in other local squirrels. As in the tree squirrels, there is a definite neck constriction. The tail is long, heavily furred, and flat in appearance. The legs are long and slender, the toes long, distinct, and flexible, the claws sharp and relatively weak. The ear pinnae are erect, variable in height, but usually long and pointed.

The fur is dense and soft, covering all parts of the body except the rhinarium and the distal parts of the soles of the feet. The hairs on the back are of three types: (1) short, crinkly "wool" hairs, which are very abundant, dark bluish-gray in color, and make up most of the underfur; (2) longer, harsher overhairs, often slender and crinkly at the base, dark basally and at the extreme tip, but with a subterminal band that may be white, yellow, brown, or black, depending on its place in the color pattern of the chipmunk; and (3) long, glossy, black guard hairs, which are relatively few in number and widely spaced.

The color pattern consists essentially of series of alternating light and dark longitudinal stripes superimposed on a "ground" color of ochraceous or gray. There are two series of stripes, facial and dorsal. The dark stripes are always darker, the light stripes paler, than the ground color. The underparts are white, more or less suffused with the ochraceous color of the sides. The dark dorsal and light ventral colors blend evenly along the lower parts of the sides.

The facial stripes are five in number on each side, three dark and two light; they are bordered above by the grizzled ground color of the crown of the head and below by the white or grayish cheeks. The dark stripes converge anteriorly at the snout, in most instances separating the white stripes completely. The uppermost, or superciliary, dark stripe is usually faintly developed, not contrasting strongly with the color of the crown. The white stripe below it passes just dorsal to the eye. The dark ocular stripe is the most conspicuous of the facial stripes, running from the mystacial area posteriorly to the base of the ear and being made up in part, in life, by the bases of the black mystacial vibrissae and by the large black eye. It is bordered below by another white stripe, and below this is the dark submalar stripe, which is sometimes obsolete anteriorly, often has a black center just below the eye, and terminates posteriorly in a large, usually diffuse, dark spot below the ear. The cheek below the submalar stripe is whitish, more or less dulled by gray or ochraceous. In dark races, such as *ochrogenys,* the dark suffusion on the cheek may be condensed into a spot suggesting an incipient genal stripe.

The backs (convex surfaces) of the ears are black on the anterior half or two-thirds and white posteriorly; there is a whitish postauricular patch on the neck behind each ear.

There are five dark and four light dorsal stripes. The single median dark stripe is the longest and usually the most conspicuous, extending in some individuals anteriorly to the crown of the head and posteriorly to the base of the tail. The two outer pairs of dark stripes are successively shorter and paler. In some forms the outermost stripe can scarcely be detected. The four light stripes are in two pairs; the inner pair is often only slightly paler than the ground color; the outer pair is more conspicuous, usually pure white.

There is no underfur on the tail; all the hairs are long and relatively coarse. They are reddish or yellowish at the base. On the hairs of the underside of the tail this color is continued to the tip. The hairs on the sides and upper parts of the tail each have a broad subterminal band of black and a white or buffy tip. At the tip of the tail in some species, the black parts of the hairs are elongated, and form a broad black subterminal area on the underside. The white or buffy tips give the tail a frosted appearance above and a definite edging along the sides. The hairs on the feet are short and coarse, usually paler than the dorsal body color.

The skull, compared with those of other Californian genera of squirrels, is long and narrow. The zygomatic arches are closely appressed to the skull. The rostrum is long, pointed at the tip, and broadens evenly posteriorly, so that there is no abrupt constriction anterior to the maxillary zygomatic processes. The dorsal outline of the skull, as viewed from the side, is evenly arched. The orbits are large, high on the skull, and close together, as in the ground squirrels. The postorbital processes are slender and sharply pointed.

The teeth are relatively small. The incisors are slender and sharp, the lower pair awl-like rather than chisel-like. There are two upper premolars, the anterior of which is a simple slender peg. The upper molar pattern is characteristic in that the posterior of the two main cross ridges (metaloph) diverges externally from the anterior (protoloph).

GEOGRAPHIC DISTRIBUTION

Because of preference for Boreal habitats, chipmunks are most abundant in the northern part of California and in the high mountains. The distribution of the chipmunks corresponds roughly with the combined distributions of

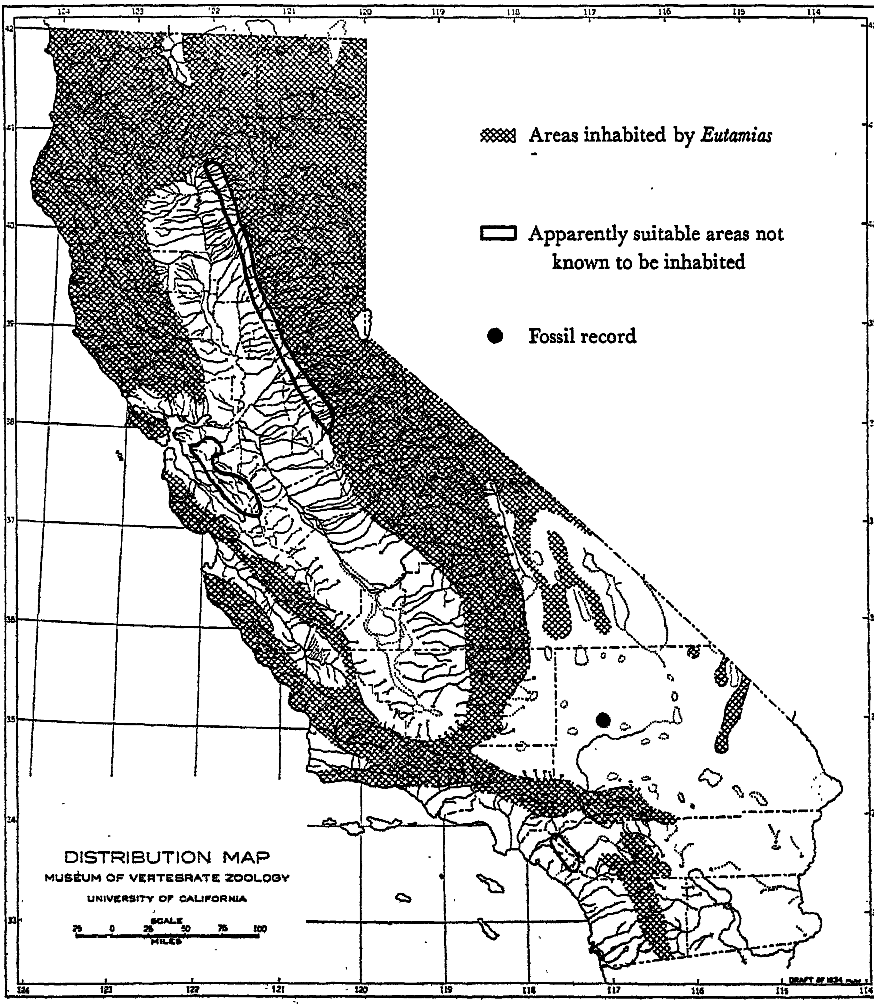


Fig. 1. Map of California, showing (1) the Recent distribution of chipmunks of the genus *Eutamias*, (2) the distribution of apparently suitable areas not known to be inhabited by chipmunks, and (3) the locality of the only known fossil record.

dense chaparral and coniferous trees in the state. The two principal areas that have not proved favorable for habitation by chipmunks are the Sacramento–San Joaquin Valley and the Mohave-Colorado Desert regions. No one species covers more than a third of the total area occupied by the genus as a whole in California.

At least three areas in the state appear to have environmental features suitable for chipmunks but are not inhabited by any species of the genus.

Two of these areas, Mount Diablo and vicinity, in west-central California, and the Santa Ana Range, in the southwestern part of the state, are apparently isolated by belts of grassland that chipmunks have never crossed. The third area is the lowest chaparral belt on the west slope of the Sierra Nevada between the Pit River and the Tuolumne River. In other parts of California, west of the crest of the Sierra Nevada, this zonal level is occupied by some member of the *sonomae-merriami* complex of chipmunks, and it is through this area that intergradation between *sonomae* and *merriami* would be expected to occur. These habitable but uninhabited areas, as well as the entire range of the genus in the state, are shown in figure 1.

VARIATION

This paper deals primarily with two types of variation, of which one is geographic, involving the heritable differences between populations within a species. It is analyzed by studying and comparing specimens from different localities within the range of the species, and, if possible, correlating the observed differences with environmental features. This may be called *intraspecific* variation, to distinguish it from the second type, *interspecific* variation, which involves the differences and the possible relationships between distinct, nonintergrading species.

Recognition of the fact that interspecific variation is distinct from intraspecific variation, as these are expressed in the group of animals in question, does not indicate that there is doubt in my mind that one is a stage that may lead to the other. In other words, geographic variants within a species may develop under favorable conditions into full species, but, once the variants have become specifically distinct from one another and no longer can or do intergrade, their relationships are altered.

In order that intra- and interspecific variations may be detected and studied, it is essential to recognize and to eliminate from immediate consideration other types of variation. These involve differences that are due to season, sex, and age. Furthermore, there is a certain range of purely individual variation which must be taken into account.

Seasonal variation in chipmunks is important only as it involves pelage changes or molts. One Californian species, *Eutamias quadrimaculatus,* has been named separately in summer and winter pelages, and specimens of other species are commonly misidentified through the inability of workers to distinguish between pelages and between different stages of wear in the same pelage. In most instances the contrast between winter and summer pelages in a single individual exceeds that between comparable pelages of different species. November-taken specimens in freshly acquired winter pelage are far more richly colored than are specimens in the worn winter pelage of May and June.

There are two complete annual molts, first satisfactorily described by Merriam (1897:192–194). The winter pelage, which is long, silky, dense, and dull-colored, is acquired in September, October, and November, the exact period varying with the individual, the race, and the region. The new fur appears first on the rump and spreads gradually forward, but without a definite molt

line to indicate just where it is replacing the old summer pelage. It is worn through the winter and well into the following summer. The summer or post-breeding pelage is acquired between May and August or, on occasion, even later. The approximate date at which the molt to summer pelage occurs depends partly on the sex of the animal; males molt before females. The exact factors that initiate the molt are not known, but cessation of breeding activities seems to be involved. Females carrying embryos or nursing young often retain the pelage of the preceding winter well into the autumn, and molt into the "summer" pelage soon after the young have become independent. This molt begins on the nose and works posteriorly, sometimes in a uniform manner and sometimes very irregularly. There is usually an abrupt molt line where the new and the old pelages meet. Some specimens show small patches of summer fur scattered irregularly through the winter fur on the back and sides. The summer pelage, in contrast to that of the winter, is short, coarse, and brightly colored.

Sexual dimorphism is slight in chipmunks. In large series, females consistently average larger than males in every measurement, but the difference rarely exceeds three per cent and is negligible compared with age variation.

In the course of its life, an individual chipmunk undergoes extensive changes in cranial proportions. These changes include, from youth toward old age: actual widening and flattening of the entire skull; fusion of the cranial elements, with a consequent tendency toward elimination of sutures; increase in the thickness of the bones of the skull, giving the skull a more massive appearance; development of crests and ridges, especially in the occipital and parietal regions; and wearing down of the cusps of the molariform teeth. It is only through the selection of even-aged series that the cranial characters of different species or populations can be compared with accuracy.

ECOLOGIC STATUS

Chipmunks are small diurnal squirrels, inhabiting chaparral and feeding principally on small seeds. The ten Californian species have diverged into almost as many ecologic niches within the limits of the above definition.

Chipmunks are typically associated with shrubs. The large number of kinds of Californian chipmunks may result from the predominance and diversity of the chaparral type of vegetation over a large part of the state. Certain species depart more or less from this type of habitat; for example, *E. speciosus* is typically associated with lodgepole pine trees, and *E. panamintinus* and *E. alpinus* inhabit rocky areas.

In general appearance and in habits the chipmunks are pygmy tree squirrels, just as the chaparral fields they inhabit are pygmy forests. These miniature "forests" of shrubs extend unbroken over large areas in the Coast Ranges and the foothills of the Cascades and the Sierra Nevada, and are interspersed with the true forests of trees, or serve as an understory, up to timber line on the highest mountains. In the Great Basin region sagebrush alone provides a suitable habitat for one species (*minimus*) of *Eutamias*. Thus the chipmunks have a more extensive range than the tree squirrels, and are represented in California by ten species as contrasted with the tree squirrel's two.

The availability of refuge and nesting places is probably the most important factor limiting the distribution of chipmunks. Most of the species depend on decaying logs of softwood trees, especially pines and firs, digging tunnels and nest chambers in the soft, rotten wood. For this reason these species are restricted to the vicinity of large conifers, though they do not utilize the living trees more than incidentally for food and for refuge and observation sites. Rock-inhabiting species apparently nest in rock crevices, and *E. minimus* has solved the problem of existing in regions where there are neither trees nor rocks, possibly by utilizing burrows of other mammals. Unlike the ground squirrels, chipmunks in California seldom or never dig extensive burrows in the ground, nor are they known to build tree nests like those of the tree squirrels. Their slender but exceedingly dexterous forefeet are adapted principally for handling the tiny seeds, which they gather and shell, and for climbing through the finely divided branches of shrubs, but not for digging.

The early successional stages following forest fires or logging operations in pine and fir forests, in which dead stumps and logs are scattered through fields of manzanita and *Ceanothus*, provide ideal habitats for chipmunks. They are usually abundant also at the marginal areas between forests and lakes or meadows. Climax forests, in contrast, are thinly populated with chipmunks.

The characteristic structural features of chipmunks are mostly adaptations to their mode of life. The long and pointed snout, slender incisors, large cheek pouches, and nimble fingers are especially fitted for gathering, shelling, and transporting small seeds. The long and flexible toes are used to grasp slender terminal twigs of bushes or the stalks of grasses, and the long, bushy tail serves as a balancing organ while the chipmunk climbs through fine branches and perches on swaying limbs. The small size in itself may be an adaptation for climbing into the terminal parts of bushes, where the weight of a larger animal would break the slender twigs, and it also makes possible the utilization of a greater number of natural hiding places.

KEY TO SPECIES OF EUTAMIAS INHABITING CALIFORNIA

1. Head and body length usually less than 110 mm.; greatest length of skull less than 31.5 mm.

- **2. Tail broad and flat-appearing; underside of tail bright orange-yellow; light dorsal stripes washed with buffy color. High southern Sierra Nevada** ***alpinus*** **(p. 73)**
- **2′. Tail narrow and rounded in cross section; underside of tail dull grayish-yellow; light dorsal stripes not washed with buffy color. Great Basin region and east flank of Sierra Nevada . . . .** ***minimus*** **(p. 77)**

1′. Head and body length usually more than 110 mm.; greatest length of skull more than 31.5 mm.

- **3. Tail edging distinctly buffy; length of head and body less than 130 mm.; greatest length of skull less than 36 mm.**
  - **4. Submalar dark stripe obsolete anteriorly; dark dorsal stripes usually reddish; skull flattened dorsally. Mountains of Inyo and eastern San Bernardino counties . . . .** ***panamintinus*** **(p. 90)**
  - **4′. Submalar dark stripe complete anteriorly; dark dorsal stripes usually black; skull rounded dorsally.**

5. Head and body length usually less than 120 mm.; greatest length of skull usually less than 33.5 mm. . . *amoenus* (p. 80)

5'. Head and body length usually more than 120 mm.; greatest length of skull usually more than 33.5 mm.

6. Outer light dorsal stripes not broader than inner light stripes; dark submalar stripe without black center below eye; black subterminal area on underside of tail less than 15 mm. anteroposteriorly; upper incisors not strongly recurved, tips of incisors anterior to posterior border of alveolus when skull is lying on horizontal surface. White Mountains, Inyo Mountains, and high Sierra Nevada *quadrivittatus* (p. 95)

6'. Outer light stripes broader than inner light stripes; dark submalar stripe with black center below eye; black subterminal area on underside of tail more than 15 mm. anteroposteriorly; upper incisors strongly recurved, tips of incisors posterior to posterior border of alveolus. Sierra Nevada and mountains of southern California *speciosus* (p. 102)

3'. Tail edging white or faintly buffy; length of head and body more than 130 mm.; greatest length of skull more than 36 mm. (*E. townsendii* group.)

7. Tail less bushy; backs of ears distinctly bicolor in all pelages; tips of nasals not separated by median notch.

8. Ears relatively short, not pointed; submalar dark stripe not black below ear *townsendii* (p. 110)

8'. Ears very long and pointed; submalar dark stripe expanding into conspicuous black area below ear. Northern Sierra Nevada *quadrimaculatus* (p. 119)

7'. Tail more bushy; backs of ears unicolor or nearly so in summer pelage (bicolor in winter pelage); tips of nasals separated by small median notch.

9. Colors more reddish. North of San Francisco Bay and Mount Lassen *sonomae* (p. 123)

9'. Colors more grayish. South of San Francisco Bay and American River *merriami* (p. 130)

METHODS OF MEASURING

The following measurements are used in the systematic part of this paper:

External measurements:

Total length: Distance from tip of nose to end of tail vertebrae, to nearest millimeter, as measured in flesh by collector and recorded on specimen label.

Tail length: Distance from last sacral vertebra to end of tail vertebra, to nearest millimeter, measured by collector, as above.

Head and body length: Difference between total length and tail length.

Hind foot: Distance from heel to tip of longest claw, measured with calipers on dry study skin, to nearest 0.1 mm. Foot and ear measurements recorded by collectors on specimen labels are too variable to be used.

Ear from crown: Distance from crown of head at center of base of ear pinna to tip of pinna, exclusive of hairs, measured with calipers on dry study skin, to nearest 0.1 mm.

Cranial measurements (measured with calipers to nearest 0.1 mm.):

Condylobasal length: Distance from anteriormost surface of upper incisor to posteriormost projection of occipital condyle on same side of skull.

Greatest length: Occipitonasal length, from anterior tips of nasals to posteriormost projection of supraoccipital.

Zygomatic width: Greatest width of skull, measured across zygomatic arches.

Cranial width: Width of brain case, taken with calipers set obliquely in constriction just posterior to zygomatic processes of squamosals and anterior to auditory bullae.

Cranial depth: Depth of brain case, taken with one jaw of calipers resting on basisphenoid, between pterygoid processes, other jaw on surface of interparietal.

Interorbital width: Narrowest constriction between orbits on roof of skull.

Length of nasals: Greatest length of longer nasal.

Depth of rostrum: Shallowest part of rostrum, in region of incisive foramina.

Length of incisive foramina: Average length of the two foramina, taken with caliper jaws flat across underside of rostrum.

Length of lower tooth row: Average length of two lower rows, from anterior face of Pm_4 to posterior face of M_3; not alveolar length. The lower tooth row was chosen in preference to the upper because the former is more often intact.

ACCOUNTS OF RECENT SPECIES

Eutamias alpinus Merriam

Tamias alpinus Merriam, 1893*b*:137 (new species); Allen, 1894:24; Trouessart, 1897:431.

Eutamias alpinus, Merriam, 1897:194; Miller and Rehn, 1901:40; Stephens, 1906:77; Miller, 1912:307; Grinnell, 1913:349; Swarth, 1919:406; Howell, 1922:183; Grinnell, 1923:322; A. B. Howell, 1924:34; Grinnell and Storer, 1924:190; Miller, 1924:199; Anthony, 1928:327; Howell, 1929:34; Grinnell, 1933:127.

Tamias minimis alpinus, Elliot, 1901*a*:79.

Tamias minimus alpinus, Elliot, 1901*b*:488, 1905:94, 1907:157.

Eutamias minimus alpinus, Trouessart, 1904:333.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 30507/42491; female adult, skin and skull; Big Cottonwood Meadows, 10,000 feet altitude, Sierra Nevada, Inyo County, California; August 12, 1891; collected by B. H. Dutcher, original no. 191. (Merriam, 1893*b*: 137; Lyon and Osgood, 1909:173.)

This geographically restricted species is apparently not closely related to any other in the genus. It agrees with *Eutamias minimus* in its small size and was treated as a subspecies of that species by Elliot (1901*a*, *b*, 1905, and 1907), but, as Merriam (1897) pointed out in the original description of *alpinus*, its unique characters set it off as a distinct species. Howell (1929) treats it as the sole member of the "*Eutamias alpinus* group."

Geographic distribution.—Highest parts of crest and principal western spurs of Sierra Nevada, in central California, from Mount Conness, Tuolumne County (Howell, 1929:35) south to Olancha Peak (fig. 2). Westernmost records of occurrence are Mount Hoffmann, Mount Clark, Horse Corral Meadows, and Mineral King (Howell, *loc. cit.*, p. 35); easternmost records are Warren Fork of Leevining Creek, Mono Pass, Onion Valley, and Little Cottonwood Creek.

The known altitudinal range is from 7600 feet (Horse Corral Meadows) to 12,600 feet (Mount Gould); the species is rarely found below 9000 feet elevation, and it is not known how far individuals venture toward the tops of the

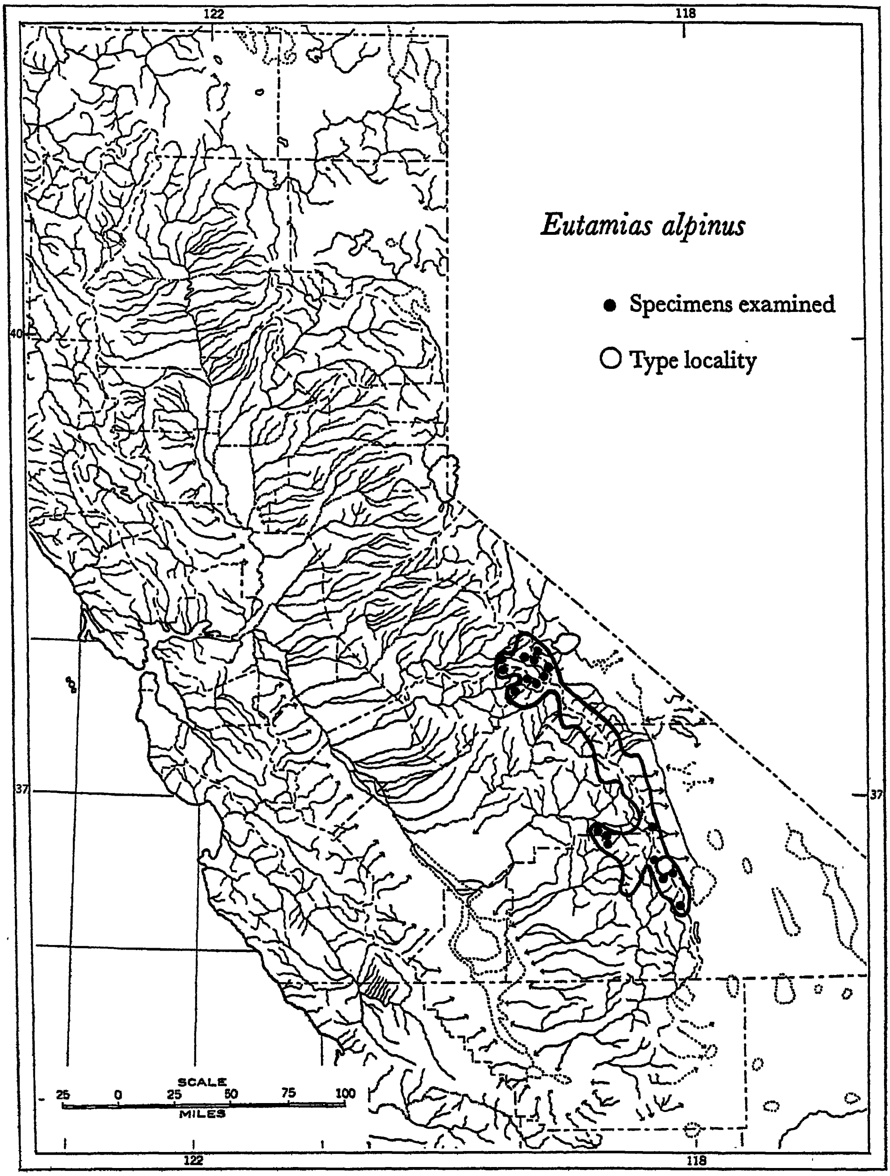


Fig. 2. Distribution of *Eutamias alpinus* in California.

highest peaks. The life-zones inhabited are chiefly Hudsonian and Arctic-Alpine; locally Canadian.

Habitat.—Cliffs and talus areas near timber line. Predominantly a rock-dweller, but occasionally found about logs and mats of stunted pines. Forages principally in open, nonforested areas, such as talus slopes at bases of canyon walls and rocky borders of meadows and lakes. Rarely climbs trees; occasionally noted on trunks of white-bark pine and lodgepole pine.

Characters.—Size small (about as in *minimus*); length of head and body

averaging about 104 mm.; condylobasal length of skull averaging about 27.0 mm.; weight of adult males averaging about 34 grams. Tail short, its length averaging about 73 per cent of head and body length. Feet moderately long; length of hind foot (dry) averaging about 27.5 per cent of head and body length. Ears short, but pointed; length (from crown on dry skin) averaging about 8.6 per cent of head and body length. Fur relatively long, fine, and silky, in both summer and winter pelage.

Colors generally yellowish; black color greatly restricted; ochraceous color extensive but dilute; markings relatively obscure; light and dark stripes weakly contrasted. Crown of head yellowish-gray. Light dorsal and facial stripes, cheeks, and underparts washed with ochraceous. Dark facial stripes brown, narrow, but distinct. Dark dorsal stripes brown; median stripe usually darkest, sometimes nearly black. Sides pale. Tail bushy, broad, and flattened; central reddish area on underside well defined; ventral submarginal black area narrow and indistinct at sides, becoming more prominent posteriorly, and forming a conspicuous and extensive (about 18 mm. anteroposteriorly) black subterminal area; edging of tail buffy, approximately same color as sides. Feet pale, nearly white. Black basal parts of hairs extensive, generally showing through lighter-colored terminal parts on sides of body.

Skull (pl. 6, *a*) large in proportion to body size; broad and flattened. Zygomatic arches moderately appressed to skull; their outer edges straight and nearly parallel, slightly convergent anteriorly; relatively narrow at base. Nasals long, averaging about 9.5 mm., or about 35.0 per cent of condylobasal length. Interorbital region broad. Brain case broad, nearly vertical-sided, and flat-topped; depressed medially at frontoparietal suture. Auditory bullae small, recessed. Foramen magnum high and narrow; its dorsolateral margins more or less concave. Palate relatively broad and flat. Incisors short; rows of cheek teeth bowed outward.

Comparisons.—The only Californian chipmunk that is as small as *Eutamias alpinus* is *E. minimus;* characters distinguishing the two are given under the account of *minimus* (p. 79). Characters other than size by which *E. alpinus* may be distinguished from *E. amoenus* are given on page 83, and from *E. panamintinus* on page 93. The remaining species are so much larger than *alpinus* that no further characters need be given here.

Measurements.—See table 1, page 76.

Specimens examined.—A total of 229, from localities in California as follows: *Tuolumne County:* Cold Canyon, 8000 ft., 1; Young Lake, near Ragged Peak, 1; Glen Aulin, Tuolumne R., 1; Colby Mtn., 9700 ft., 1; vicinity of Ten Lakes, 9200–9700 ft., 7; 3 mi. N Tuolumne Meadows, 1; Tuolumne Meadows, 17; Dana Fork of Tuolumne R., 2; Lyell Canyon, 9700–11,000 ft., 17. *Mariposa County:* Mt. Hoffman, 10,200–10,700 ft., 10; near Vogelsang Peak, 9800 ft., 1; Fletcher Cr., 10,200 ft., near Vogelsang Lake, 1; Vogelsang Lake, 3; McClure Fork of Merced R., 1; Mt. Clark, 10,000 ft., 6. *Madera County:* Mt. Florence Ridge, 10,000–10,500 ft., 3. *Mono County:* Warren Fork of Leevining Cr., 9700–10,000 ft., 3; Tioga Road, 9600 ft., 1; Tioga Road, near Ellery Lake, 1; W. slope Tioga Peak, 9700 ft., 1; Mono Pass, 1. *Fresno County:* Horse Corral Meadows, 1; Bullfrog Lake, 23; Mt. Gould, 12,600 ft., 1. *Tulare County:* Mitchell Peak, 9500 ft., 1; Twin Peaks, 1; Twin Lakes, 3; Whitney Cr., 10,650 ft., 3; Cirque Peak, 11,000–11,500 ft., 6; Whitney Meadow, 22; Olancha Peak, 9750–10,500 ft., 8. *Inyo County:* Mt. Kearsarge, 11,500 ft., 1; Kearsarge Pass, 8500–10,500 ft., 30; Onion Valley, 13; Cottonwood Lakes, 36.

TABLE 1

AVERAGE AND EXTREME MEASUREMENTS IN MILLIMETERS OF ADULTS OF *Eutamias alpinus* AND *Eutamias minimus*

Total length	Head and body length	Tail length	Hind foot (dry)	Ear from crown (dry)	Condylo-basal length	Greatest length of skull	Zygomatic breadth	Cranial breadth	Cranial depth	Interorbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias alpinus from Tuolumne, Mariposa, and Mono counties														
10 males					10 males									
174 166–184	103 87–115	71 63–81	28.0 26.6–29.0	8.7 8.1–9.4	26.5 25.8–27.2	29.8 28.9–30.4	16.9 16.3–17.6	14.6 14.3–14.9	9.9 9.6–10.2	7.2 6.8–7.3	9.3 8.9–9.8	4.3 3.9–4.6	2.2 1.7–2.5	4.5 4.4–4.6
8 females					10 females									
177 169–181	105 98–112	72 63–76	28.1 27.1–29.3	8.6 8.1–9.7	26.7 26.1–27.5	30.0 29.3–31.0	17.1 16.5–17.6	14.7 14.1–15.0	9.9 9.5–10.2	7.2 7.0–7.7	9.5 9.1–9.8	4.3 4.1–4.5	2.3 2.1–2.5	4.7 4.6–4.8
Eutamias minimus from White Mountains, Mono and Inyo counties														
6 males					9 males									
181 176–183	104 99–108	77 72–80	28.1 27.3–29.2	8.2 7.5–9.1	26.4 26.1–27.0	29.7 29.2–30.3	16.6 16.2–16.9	14.7 14.3–15.1	10.0 9.6–10.5	6.8 6.6–7.2	8.8 8.4–9.5	4.4 4.2–4.6	2.0 1.9–2.3	4.6 4.4–4.7
11 females					10 females									
191 180–196	110 100–115	81 77–88	28.6 27.7–29.8	8.3 7.9–9.0	26.9 26.5–27.3	30.2 29.7–30.5	16.7 16.2–17.2	14.8 14.1–15.2	10.2 9.8–10.5	6.9 6.5–7.2	9.1 8.7–9.6	4.3 4.1–4.6	2.0 1.9–2.2	4.6 4.4–4.8

Remarks.—The restricted range of *Eutamias alpinus,* the general uniformity of its habitat, and the absence of low-zone barriers separating the various populations are factors that should tend to make the species uniform in characters. Therefore it seems remarkable that specimens from the northern part of its range have slightly smaller skulls and shorter tails than those from the southern localities. These differences in themselves are not sufficient to warrant subspecific designation of a northern race, and there seem to be no correlated color differences.

Many authors have commented on the unusually high zonal range of *Eutamias alpinus.* It is interesting to note, however, that where this species occurs with *E. quadrivittatus* and *E. speciosus* in the Mount Whitney region, *quadrivittatus* is actually restricted to higher elevations than is *alpinus.* At Whitney Meadows *alpinus* was regularly found in the rocky submarginal area surrounding the meadows, where it came in contact with *speciosus,* whereas *quadrivittatus* was found only higher on the windswept ridges.

Eutamias minimus Bachman

Tamias minimus Bachman, 1839:71.

Chipmunks of this species are the smallest and in some respects the most specialized in California. Of the ten species of *Eutamias* in the state, this is the only one that is not restricted to the vicinity of coniferous trees.

Geographic distribution.—In California, northeastern and central-eastern parts of state, except near Lake Tahoe, mainly east of Cascade-Sierran divide; south to southeastern Tulare County (fig. 3). Some westernmost records of occurrence, arranged from north to south, are: Mount Hebron, Siskiyou County (Howell, 1929:40); Spalding's, Eagle Lake; Vinton; Diamond Valley; Walker Lake; Bishop Creek, at 7000 ft., Inyo County (Howell, 1929:40); Olancha Peak; and Chimney Meadow, Tulare County (W. B. Richardson, unpublished MS). Southernmost record in Sierra Nevada is Chimney Meadow, Tulare County; southernmost record east of Sierra Nevada is Mazourka Canyon, Inyo Mountains. Outside California, *Eutamias minimus* occupies a more extensive geographic area than does any other North American species in the genus. Its range, of which only the southwestern border touches California, extends northward, interiorly from the coast, into Yukon Territory; eastward through the Canadian forests to central Ontario and northern Michigan; and southward through the Rocky Mountain and Great Basin regions to southern Arizona and New Mexico (Howell, 1929:37).

The known altitudinal range in California is from 4000 feet (Warm Spring, Lassen County) to 10,500 feet (three localities: Cottonwood Creek, Big Prospector Meadow, and Blanco Mountain, all in the White Mountains, Mono County). The species occurs chiefly in the Upper Sonoran and Hudsonian Life-zones; rarely in the intervening Transition and Canadian zones, which usually are absent or only weakly developed within its range.

Habitat.—Tracts of sagebrush in all its forms of growth, but especially where tall and in fairly compact stands; on soil varying from fine wind-blown sand of valley-bottom dunes to crevices in rock ledges. Frequently found near

trees growing amid sagebrush, including western juniper, piñon, yellow and Jeffrey pines, aspen, and mountain mahogany, and with associated shrubs, such as rabbitbrush, bitterbrush, saltbush, and ephedra.

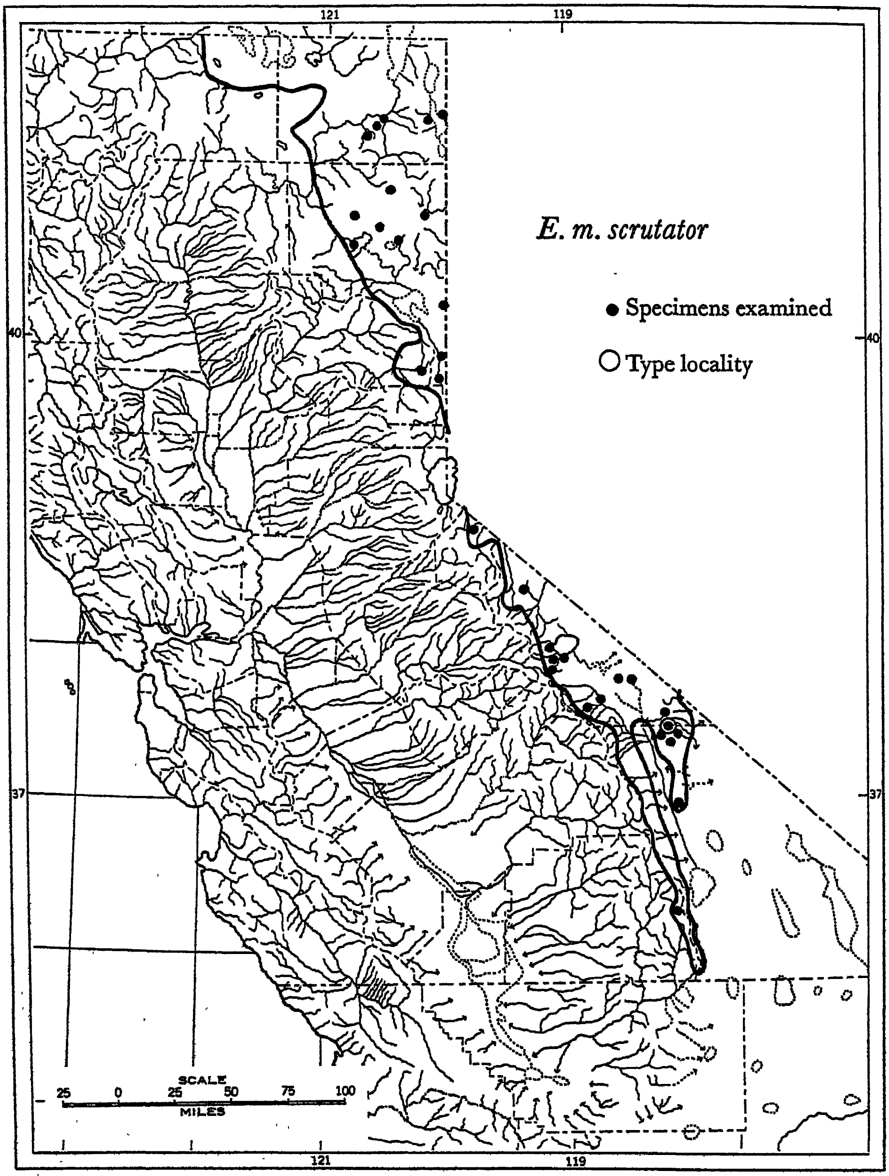


Fig. 3. Distribution of *Eutamias minimus* in California.

Characters.—Size small; length of head and body averaging about 108 mm.; condylobasal length of skull averaging about 26.6 mm.; weight of adult males averaging about 35 grams. Tail relatively long, its length averaging about 78 per cent of head and body length. Feet relatively long; length of hind foot (dry) averaging about 28 per cent of head and body length. Ears short,

rounded; length (from crown on dry skin) averaging about 7.5 per cent of head and body length.

Color pattern conspicuous in summer pelage; light and dark areas well defined, not tending to blend together. Appearing dark in dorsal view, because dark stripes are broader than light stripes. Pale in lateral and ventral views; sides yellowish; shoulders grayish. Facial stripes prominent; dark stripes narrow but well defined, nearly black centrally; submalar stripe obsolete anteriorly. Light facial stripes and cheeks faintly washed with ochraceous. Anterior margins of ears rusty brown. Median dark dorsal stripe narrow, black; submedian dark stripes broad (broadest of all the dorsal stripes), dark brown with scattered, but not centralized, black hairs throughout; outermost pair of dark stripes similarly colored, but shorter and narrower. Light dorsal stripes narrow, but conspicuous; inner pair ashy gray; outer pair white; not or only slightly washed with ochraceous. Tail narrow and rounded rather than broad and flattened; yellowish area on underside poorly defined, dulled by sprinkling of dark hairs.

Skull (pl. 6, *b*) smaller than in any other Californian chipmunk; in general proportions high and narrow. Rostrum short, its upper surface steeply sloping. Interorbital region narrow. Dorsal outline, in lateral view, strongly arched. Brain case rounded dorsally. Zygomatic arches closely appressed to skull. Incisors relatively long and recurved; rows of cheek teeth bowed outward centrally, about equidistant from one another anteriorly and posteriorly.

Comparisons.—*Eutamias minimus* is the smallest Californian chipmunk; this character alone will separate it readily from the other species except *E. alpinus*. Further characters by which it may be distinguished from *E. amoenus* are given on page 83; and from *E. panamintinus*, on page 93.

Compared with *Eutamias alpinus*, *E. minimus* has a longer tail, narrower and more rounded in cross section, dull grayish-yellow rather than bright orange beneath; shorter and harsher fur; darker dorsal coloration; less ochraceous light dorsal stripes; and a smaller, narrower skull with a smaller and less-flattened brain case, shorter and more pointed rostrum, narrower palate, and longer incisors.

Measurements.—See table 1, page 76.

Subspecies.—The greatest geographic variation occurs in the Rocky Mountain region, where several races have been recognized. The Californian specimens show little geographic variation and are assigned to a single subspecies.

Eutamias minimus scrutator Hall and Hatfield

Eutamias pictus, Merriam, 1897:194; Stephens, 1906:78; Grinnell, 1913:349; Grinnell and Storer, 1924:195.

Tamias minimis pictus, Elliot, 1901*a*:79.

Eutamias minimus pictus, Miller and Rehn, 1901:42; Trouessart, 1904:333; Miller, 1912:311; A. H. Howell, 1922:183; Grinnell, 1923:322; A. B. Howell, 1924:34; Miller, 1924:199; Mailliard, 1927:347; Anthony, 1928:234; A. H. Howell, 1929:39; Grinnell, Dixon, and Linsdale, 1930:485; Grinnell, 1933:127.

Tamias minimus pictus, Elliot, 1905:94, 1907:157.

Eutamias minimus scrutator Hall and Hatfield, 1934:321 (new subspecies); Bole, 1938:245.

Type.—Mus. Vert. Zoöl., no. 27352; male adult, skin and skull; near Blanco Mountain, 10,500 feet altitude, White Mountains, Mono County, California; July 28, 1917; collected by J. Grinnell, original no. 4359.

Geographic distribution.—In California, as given above for the species. Outside California, parts of southeastern Oregon, south-central Washington, northern and central Nevada, western Utah, and southwestern Idaho.

Specimens examined.—A total of 153, from localities in California as follows: *Modoc County:* South Fork Pit R., near Alturas, 2; 5 mi. SW Alturas, 1; 10 mi. SW Alturas, 1; 6 mi. E Cedarville, 1; Dry Cr., 4600–4800 ft., Warner Mts., 9. *Lassen County:* 2 mi. S Madeline, 1; 7 mi. N Observation Peak, 1; 6 mi. N Observation Peak, 7; Grasshopper Valley, 4; 5 mi. N Fredonyer Peak, 2; 8 mi. SW Ravendale, 1; Spalding's, Eagle Lake, 3; Warm Spring, 9 mi. E Amedee, 4; 1 mi. W Red Rock P. O., 2; Plumas Junction, 1. *Plumas County:* Vinton, 1; 1 mi. E Vinton, 1. *Alpine County:* Diamond Valley, 1 mi. SE Woodfords, 2. *Mono County:* Devils Gate Pass, 2 mi. E Fales Hot Springs, 1; Mono Lake P. O., 2; vicinity of Williams Butte, 6900–7000 ft., 8; 3 mi. W Williams Butte, 1; Farringtons, 1; Walker Lake, 1; Mono Lake, near Mono Craters, 2; Mono Craters, 2; Mono Mills, 16; Dry Cr., near Mono Lake, 4; Dutch Pete's Ranch, 4 mi. W Benton, 4; McKeever's Ranch, 2 mi. S Benton, 1; Taylor Ranch, 2 mi. S Benton Station, 1; Long Valley, 7300 ft., near Convict Cr., 1; Owens R., 6800 ft., 4 mi. E Whitmore Tub, 1; Cottonwood Cr., 9000–10,500 ft., White Mts., 8; near Big Prospector Meadow, 10,300–10,500 ft., White Mts., 9; near Blanco Mtn., 10,500 ft., White Mts., 4; 2 mi. E Big Prospector Meadow, 10,000 ft., White Mts., 2. *Inyo County:* Vicinity of Roberts Ranch, 8200–8300 ft., Wyman Cr., White Mts., 9; ridge east of head Silver Canyon, 9500 ft., White Mts., 2; ridge at head Black Canyon, 9000 ft., 12; 2½ mi. SE head Black Canyon, 8000 ft., White Mts., 12; Mazourka Canyon, 8300–8500 ft., Inyo Mts., 4. *Tulare County:* Little Brush Meadow, 9750 ft., Olancha Peak, 1.

Remarks.—The distribution of this species in California is conditioned by the distribution of its habitat, arid areas grown to tall sagebrush, which in the Great Basin region occur in several life-zones. In the vicinity of the White Mountains, *Eutamias minimus* is abundant on the sagebrush-covered upper slopes of Owens Valley up to 7000 feet altitude, rare in the piñon belt between 7000 and 9000 feet, and abundant again in the sagebrush on the mountain tops above 9000 feet. Thus, the species ranges from the Upper Sonoran Zone to the Hudsonian Zone, but occupies a uniform type of habitat throughout.

There is considerable individual variation in pelage characters, involving chiefly the relative widths of the dorsal stripes and the extent of black in the dark stripes.

The specimen from Olancha Peak is the only one I have seen from far south in the Sierra Nevada, where conditions are more humid than over most of the range of the race *scrutator*, and this specimen has the sides definitely more saturate with ochraceous than do specimens from other localities in California. If enough specimens were at hand to indicate the constancy of this character, it might be found to distinguish a subspecifically different population.

Eutamias amoenus Allen

Tamias amoenus Allen, 1890:61 and 90.

The Californian representatives of this species occupy the southwesternmost extension of a broad range that covers most parts of the northwestern United States and southwestern Canada. The only species closely related to it is *Eutamias panamintinus*.

Geographic distribution.—In California, higher parts of Siskiyou, Salmon, Scott, South Fork, and Yolla Bolly ranges in northwestern part of state; crest

and eastern slope of Cascade-Sierran divide, from Oregon state line south to Mammoth Pass; Warner Mountains and higher parts of Great Basin plateau in Modoc and Lassen counties (fig. 4). Outside California, Olympic and Cas-

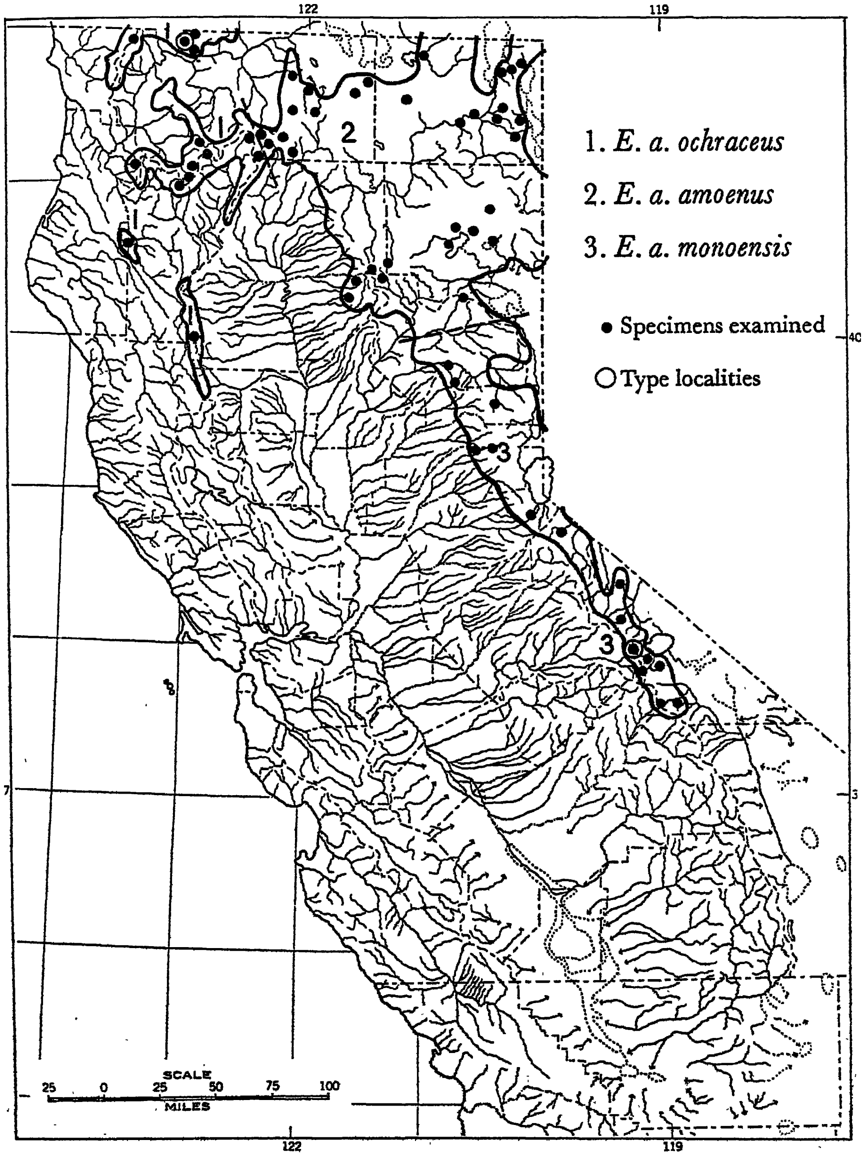


Fig. 4. Distribution of *Eutamias amoenus* in California.

cade ranges, northern Great Basin, and northern Rocky Mountains; interiorly from the coast, except in southern British Columbia; north to Hazelton, British Columbia; east to slightly beyond Continental divide in Alberta and Montana; south to Salt River Mountains in Wyoming, Blue Spring Hills (west of Malad) in Idaho, and to Jarbridge and Pine Forest mountains in Nevada

(Howell, 1929 :62–77, and additional specimens in Mus. Vert. Zoöl. and Ralph Ellis Coll.).

This species inhabits chiefly the Transition Zone, commonly extending its range, where conditions are favorable, into the Canadian Zone. In the mountains of northwestern California it occurs along the summits, in part as isolated populations, down to elevations as low as 5000 feet in the Siskiyou, Salmon, and Scott mountains, to 5700 feet in the South Fork Mountains, and to between 5000 and 6000 feet in the Yolla Bolly region. In Squaw Creek Valley, south of Mount Shasta (Merriam, 1889 :90), and on the divide between the Shasta and Sacramento rivers, west of Mount Shasta, it descends to about 3200 feet, its lowest elevation in California. The known vertical range in other places in the Mount Shasta region is from 4000 feet (Little Shasta River) to about 8000 feet (near timber line); in the Mount Lassen region, from 4800 feet (2 mi. W Mineral) to 8200 feet (Lake Helen); in Alpine County, from 5500 feet (Diamond Valley) to 9500 feet (Hawkins Peak); and in the Sierra Nevada west of Mono Lake, from 7000 feet (Williams Butte) to 9400 feet (Tioga Road).

Habitat.—Open places in coniferous forests. In northwestern California, the Cascades, and the northern Sierra Nevada, at borders of meadows and about rock outcroppings and logs surrounded by chaparral on high ridges; along the east slope of the Sierra Nevada and in the northeastern Great Basin region, about logs and rock ledges surrounded by sagebrush and other chaparral in the open growths of yellow pine and juniper. Forages over open ground, about logs and rocks, and in chaparral; occasionally climbs trees. Typically found in open, sunny places, where the ground is relatively exposed and trees and bushes are widely spaced; especially abundant where half-rotten stumps and logs are surrounded by chaparral, as in the early successional stages following burning or logging. Has been noted in association with yellow, Jeffrey, and sugar pines, incense cedar, Brewer spruce, black oak, mountain mahogany, snowbrush, service berry, willow, bitterbrush, and sagebrush.

Characters.—Size small; length of head and body averaging about 117 mm.; condylobasal length of skull averaging about 29.4 mm.; weight of adult males averaging about 45 grams. Tail length medium, averaging about 73 per cent of head and body length, but quite variable. Feet short; length of hind foot (dry) averaging about 26.6 per cent of head and body length. Ears short, averaging (from crown on dry skin) about 9.2 per cent of head and body length.

Richly colored, especially in summer pelage; light parts of pattern more or less suffused with ochraceous, hence not contrasting sharply with darker parts. Crown of head dark brown, grizzled with whitish hairs; sides bright Ochraceous-Tawny (names of colors with initial capital letters are those of Ridgway [1912]) in summer pelage, slightly frosted with white-tipped hairs over shoulders. Dark facial stripes dark brown; superciliary and submalar stripes lacking solidly black areas, but heavily sprinkled with black hairs. Light facial stripes and cheeks dulled by suffusion with ochraceous. Postauricular light patches inconspicuous. Dorsal stripes all about equally broad; three innermost dark stripes black over midback, becoming brown ante-

riorly; outermost dark stripes relatively conspicuous as compared with those of other species, brown with many black hairs scattered throughout. Light dorsal stripes more or less suffused with ochraceous and merging with adjacent black stripes through intermediate borders of bright ochraceous; inner pair of light stripes gray, equal to or broader than outer whitish pair. Underside of tail slightly darker than sides of body; black submarginal area well defined, less than 10 mm. broad anteroposteriorly at tip of tail; outermost edging buffy, slightly paler than central area.

Skull (pl. 6, *c*) appearing narrow in dorsal view because anterior tips of nasals are prolonged; otherwise relatively broad; zygomatic breadth averaging about 62.4 per cent of condylobasal length. Dorsal outline strongly arched in lateral view; roof of brain case not flattened. Zygomatic arches closely appressed to skull; slanting inward anteriorly from squamosal region. Rostrum long and narrow; tips of nasals prolonged anteriorly. Upper incisors sharply recurved. Incisive foramina short, averaging about 2.2 mm. in length.

Comparisons.—*Eutamias amoenus* is a small chipmunk, and may be distinguished on the basis of its small size alone from the four largest Californian species: *townsendii, quadrimaculatus, sonomae,* and *merriami.* It is also appreciably smaller than the members of the *quadrivittatus* group; for further characters separating *amoenus* from *E. q. inyoensis,* see page 97; and from *E. speciosus,* page 104.

Eutamias amoenus is approximately the same size as its nearest Californian relative, *E. panamintinus,* but differs in having slightly longer feet and ears, generally darker coloration, brown rather than gray crown of head, much broader and more heavily pigmented dark facial stripes, more conspicuous dark dorsal stripes (in *panamintinus* only the median one is black and the outermost pair is barely perceptible), and relatively broader inner and narrower outer light stripes. The skull of *amoenus* is narrower in general, the roof of the brain case rounded rather than flattened, the brain case itself much narrower, the nasals more prolonged anteriorly, the incisive foramina shorter, and the upper incisors more recurved.

From *Eutamias minimus, E. amoenus* may be distinguished by larger size, darker color, reddish rather than yellowish sides of body and underside of tail, more ochraceous cheeks and underparts, black rather than brown dorsal dark stripes, broader and more flattened tail (central reddish area on underside about 9 mm. broad and uniformly colored, rather than about 5 mm. broad and sprinkled through with darker hairs as in *minimus*). The skull of *amoenus* is more flattened, with relatively narrower and shallower brain case, more flaring (less appressed) zygomatic arches, longer rostrum, more recurved incisors, and relatively (though not actually) narrower palate.

From *Eutamias alpinus, E. amoenus* differs in its greater size, generally darker coloration, more ochraceous sides, cheeks, and underparts, black rather than brown dark dorsal stripes, and more restricted black area near tip of underside of tail (about 10 mm. rather than about 18 mm. anteroposteriorly). The skull of *amoenus* may be distinguished from that of *alpinus* by the characters used to distinguish *amoenus* from *minimus* (see preceding paragraph).

Measurements.—See table 2, pages 88–89.

Subspecies.—The three Californian subspecies here recognized are weakly differentiated, full intergrading geographic races. They are based on average color and size characters of series having great individual variation, hence some specimens are difficult to assign to one race or another except on geographical grounds. Intergradation between subspecies takes place gradually, and the boundaries are necessarily somewhat arbitrary. The three races are distinguished chiefly as follows:

Colors dark; dorsal stripes washed with reddish brown; size large. Siskiyou, South Fork, Salmon, Scott, and Yolla Bolly mountains . . . . *ochraceus* (p. 84)
Colors medium; dorsal stripes usually without reddish color except at borders; size medium. Cascade-Sierran Range north of Feather River, Modoc Lava Beds region, and Warner Mountains . . . . *amoenus* (p. 85)
Colors pale; dorsal stripes not sharply defined; size small. Sierra Nevada from Feather River to Mammoth Pass, mainly on east slope . . . . *monoensis* (p. 86)

Eutamias amoenus ochraceus Howell

Eutamias amoenus amoenus, Kellogg, 1916:373; Mailliard, 1921:80; Howell, 1929: 61 (part); Grinnell, 1933:127 (part).
Eutamias amoenus ochraceus Howell, 1925:54 (new subspecies); Anthony, 1928: 233; Howell, 1929:64; Grinnell, 1933:128; Bailey, 1936:137.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 161049; male adult, skin and skull; Studhorse Canyon, 6500 feet altitude, Siskiyou Mountains, Siskiyou County, California; September 27, 1909; collected by N. Hollister, original no. 3311. (Howell, 1925:54, 1929:64.)

Geographic distribution.—In California, mountains of northwestern part of state, including Siskiyou, South Fork, Salmon, Scott, and Yolla Bolly ranges (fig. 4). Range extends north to Oregon state line in Siskiyou Mountains; westernmost records of occurrence are: Head of Dunn Creek (whence probably extends farther southwest to include Preston Peak), head of Redcap Creek, and Blake Lookout; southernmost record is 4 miles south of S. Yolla Bolly Mountain (whence probably extends south into northwestern Glenn County); easternmost records are: Head of Doggett Creek, Dale Creek, Castle Lake, and west side of Thoms Creek. Outside California, only in Siskiyou Mountains of southern Josephine and Jackson counties, Oregon.

The four populations thus included are separated from one another by low-zone barriers formed principally by the canyons of the Klamath and Trinity rivers. There is continuity of range between the Siskiyou Mountains and Salmon Mountains populations around through another subspecies, *amoenus*, in the southern Cascades, but the South Fork Mountain and Yolla Bolly Mountain populations are entirely isolated.

Characters and comparisons.—Color in general darker, more reddish and less grayish, than in subspecies *amoenus;* sides in summer pelage darker; ochraceous tips of hairs more abundant and individually more extensive, usually sprinkled throughout dark dorsal stripes; alternate light and dark dorsal stripes less sharply contrasting, due to suffusion of all the dorsal stripes with reddish color. Size slightly greater than in *monoensis* and most populations of *amoenus*. Skulls averaging slightly larger than in other subspecies; otherwise similar.

Specimens examined.—A total of 169, from the following localities in California: *Del Norte County:* Head east fork Dunn Cr., Siskiyou Mts., 1; Del Norte–Siskiyou county line, 5600 ft., 5¾ mi. S Oregon state line, Siskiyou Mts., 1. *Siskiyou County:* Poker Flat, 5000 ft., 12 mi. NW Happy Camp, Siskiyou Mts., 1; Donomore Meadow, 5800 ft., 15 mi. W Hilt, Siskiyou Mts., 2; Studhorse Canyon, 6500 ft., Siskiyou Mts., 1; head Doggett Cr., 5800 ft., Siskiyou Mts., 19; Dale Cr., 6000–6200 ft., E. slope Mt. Eddy, 2; Castle Lake, 5434 ft., 2; Jackson Lake, 5900 ft., Salmon Mts., 31; Wildcat Peak, 7200 ft., Salmon Mts., 7; Saloon Cr. divide, Salmon Mts., 7; head Bush Cr., 6400 ft., Salmon Mts., 19; South Fork Salmon R., 5000 ft., Salmon Mts., 5. *Humboldt County:* Head Redcap Cr., 5800 ft., 10 mi. E and

4 mi. N Hoopa, 3; near Blake Lookout, 5700 ft., South Fork Mtn., 2. *Trinity County:* Head Deadfall Cr., W. slope Mt. Eddy, 3; head Bear Cr., 6400 ft., W. slope Mt. Eddy, 19; head Grizzly Cr., 6000 ft., Salmon Mts., 2; S. Yolla Bolly Mtn., 1; ½–2 mi. S S. Yolla Bolly Mtn., 10. *Tehama County:* S. Yolla Bolly Mtn., 8; ½–4 mi. S S. Yolla Bolly Mtn., 22; W. side Thoms Cr., S. Yolla Bolly Mtn., 1.

Eutamias amoenus amoenus Allen

Tamias asiaticus Townsendi, Townsend, 1887: top of page 171 (part, specimens not seen by me, referred to *amoenus* by Allen, 1890:91).

Tamias amoenus Allen, 1890:61 and 90 (new species); Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:431; Elliot, 1901*a*:74, 1901*b*:467, 1905:90, 1907:152.

Tamias quadrivittatus amoenus, Merriam, 1892:25, 1893*a*:383.

Eutamias amoenus, Merriam, 1897:194, 1899:90; Miller and Rehn, 1901:40; Trouessart, 1904:332; Stephens, 1906:78; Grinnell, 1913:349.

Tamias amaenus, Elliot, 1898:197.

Eutamias amoenus amoenus, Miller, 1912:307; Howell, 1922:184; Grinnell, 1923: 322; Miller, 1924:201; Mailliard, 1927:348; Anthony, 1928:232; Howell, 1929: 61; Grinnell, Dixon, and Linsdale, 1930:486; Grinnell, 1933:127.

Type.—U. S. Nat. Mus., no. 186460; female adult, skin and skull; Fort Klamath, Klamath County, Oregon; May 16, 1887; collected by J. C. Merrill; formerly in Merriam Coll., no. 3469/4096. (Allen, 1890:91; Howell, 1929:61.)

Geographic distribution.—In California, mountains of northeastern part of state, including Cascade-Sierran divide north of Feather River, Modoc Lava Beds region, and Warner Mountains (fig. 4). At the north the range reaches the Oregon state line; westernmost localities of occurrence are: Head of Little Shasta River, 3 miles southwest of Weed, and 2 miles west of Mineral; southernmost localities are: 2 miles west of Mineral and 8 miles south of Susanville; at the east the range extends to the Nevada state line at the north end of the Warner Mountains and to 8 miles southwest of Ravendale in central Lassen County. Howell (1929:63) refers to the subspecies *amoenus* specimens from more southern localities, extending the range to the South Fork of the American River, but the specimens I have seen from this area of intergradation are closer to *monoensis*. Outside California, central and southeastern Oregon, southwestern and south-central Idaho, and extreme northwestern Nevada (Howell, 1929:61–64, and additional specimens in Mus. Vert. Zoöl.).

Characters and comparisons.—Colors in general paler than in *ochraceus* and darker than in *monoensis;* sides in summer pelage brightly colored; alternate light and dark dorsal stripes more sharply contrasting than in the other subspecies, dark stripe usually black, light ones gray and white, without suffusion of reddish color except at edges (with some exceptions in each large series). Size medium, averaging slightly smaller than in *ochraceus,* larger than in *monoensis*. Skull not different except in average size.

Specimens examined.—A total of 233, from the following localities in California: *Siskiyou County:* near head of Little Shasta R., 4000 ft., N. side Goosenest Mtn., 1; Benton Estate, Butte Cr., 2; Antelope Cr., 5500 ft., 6 mi. S Tennant, 1; divide between Mt. Shasta and Black Crater, 6000 ft., 3; Mt. Shasta, 6500 ft., 9; 1 mi. S Weed, 3600 ft., 8; 3 mi. SW Weed, 3200 ft., 2; Sisson (now Mt. Shasta City), 3600–3700 ft., 4; 1 mi. E McCloud, 1; Crescent Butte, Modoc Lava Beds Nat. Mon., 1; Indian Well, 4770 ft., Modoc Lava Beds Nat. Mon., 2; vicinity of Medicine Lake, 13. *Modoc County:* Steele Meadow, 4700 ft., 7; 20 mi. NW Canby, 4500 ft., 2; vicinity of Fort Bidwell, 1; 7 mi. SE Willowranch, Warner Mts., 1; Sugar Hill, 5000 ft., Warner Mts., 10; Rattlesnake Canyon, 5000 ft., near Alturas, 1; Scott Ranch, 5000 ft., 10 mi. SW Alturas, 1; Shields Cr., 5000 ft., Warner Mts., 1; Parker Cr., 5500 ft., Warner Mts., 7; head north fork Parker Cr., 7300 ft., Warner Mts., 17; 5 mi. S Cedarville, 4700 ft., 1; E. face Warren Peak, 8700 ft., Warner Mts., 9; 5 mi. NW Eagle Peak, 7000 ft., Warner Mts., 1. *Shasta County:* Lake Helen, 8500 ft., Mt. Lassen, 1; Warner Cr., 6600–8000 ft., Mt. Lassen, 12. *Lassen County:* 4 mi. SW McDonald Peak, 5300 ft., 5; Grasshopper Valley, 3; 5 mi. N Fredonyer Peak, 5700 ft., 12; Eagle Lake, 6; Spalding's, W. side Eagle Lake, 35; 8 mi. SW Ravendale, 5600–5800 ft., 2; Butte Lake, 6500

ft., Mt. Lassen, 2; 8 mi. S Susanville, 1. *Tehama County:* 2 mi. W Black Butte, 6800 ft., 3; 2 mi. W Mineral, 4800 ft., 1; 2 mi. E Mineral, 5200 ft., 2; Summit Cr., 2 mi. E Mineral, 1. *Plumas County:* Hot Spring Valley, 39; Kelley's, 2 mi. N Willow Lake, 1; Willow Lake, 5600 ft., 1.

Eutamias amoenus monoensis Grinnell and Storer

Tamias amoenus Allen, 1890:61 and 90 (part); Elliot, 1901*a*:74 (part).

Eutamias amoenus, Merriam, 1897:194 (part); Stephens, 1906:78 (part); Grinnell, 1913:349 (part).

Eutamias amoenus monoensis Grinnell and Storer, 1916:3 (new subspecies); Howell, 1922:184; Grinnell, 1923:322; A. B. Howell, 1924:34; Grinnell and Storer, 1924:194; Miller, 1924:202; Anthony, 1928:233; Howell, 1929:65; Grinnell, 1933:128.

Type.—Mus. Vert. Zoöl., no. 23380; male adult, skin and skull; Warren Fork of Leevining Creek, 9200 feet altitude, Mono County, California; September 25, 1915; collected by J. Grinnell, original no. 3709.

Geographic distribution.—In California, central Sierra Nevada, mainly on east slope, from Feather River south to Mammoth Pass (fig. 4). Northernmost records of occurrence (approaching subspecies *amoenus*) are Mohawk and Johnsville; westernmost records are Mohawk, Cisco, Glen Alpine Cr., Tioga Road (near Tioga Pass), and Pine City; easternmost records are Independence Lake, Diamond Valley, Swager Creek, Mono Craters, and Long Valley; southernmost records are Pine City and Long Valley. Outside California, Lake Tahoe region in western Nevada. Howell (1929:66) referred a specimen from the Cottonwood Range and others from the Pine Forest Mountains, both in northern Nevada, to this subspecies; recent work (Hall and Johnson, 1940) shows the former to belong to the species *Eutamias minimus* and the latter to another subspecies of *E. amoenus.*

Characters and comparisons.—Colors in general paler, more yellowish and less reddish, than in *ochraceus* and *amoenus;* sides in summer pelage variable; light and dark dorsal stripes less sharply contrasting than in *amoenus,* dark stripes being more brownish. Size averaging smaller than in *amoenus* and *ochraceus.* Skulls not different except in smaller average size.

Specimens examined.—A total of 106, from the following localities in California: *Plumas County:* Mohawk, 4400 ft., 2; Johnsville, 5200 ft., 2; Grass Lake, 5900 ft., 2½ mi. S Johnsville, 1. *Sierra County:* Campbell's Hot Springs, 5000 ft., 1½ mi. SE Sierraville, 2. *Nevada County:* Independence Lake, 29. *Placer County:* Cisco, 6000 ft., 29; 2 mi. W Soda Springs Station, 6500 ft., 1; 3 mi. N Carnelian Bay, 7000 ft., Lake Tahoe, 1. *Eldorado County:* Glen Alpine Cr., 6600 ft., near Fallen Leaf Lake, 2. *Alpine County:* Diamond Valley, 5500 ft., 1 mi. SE Woodfords, 5; Hawkins Peak, 9500 ft., 3 mi. SW Woodfords, 1. *Mono County:* Swager Cr., 7600 ft., Sweetwater Range, 1; Robinson Cr., ½ mi. below Twin Lakes, 2; Warren Fork Leevining Cr., 9200 ft., 4; Tioga Road, 9400 ft. (near Tioga Pass), 1; Williams Butte, 7000 ft., 1; near Walker Lake, 8000–8200 ft., 10; Silver Lake, 7200 ft., 1; Gem Lake, 9036 ft., 1; Mono Craters, 7850–8000 ft., 2; 1 mi. S Mono Craters, 7700 ft., 2; Pine City, 8700 ft., near Mammoth, 5; Long Valley, 7300 ft., near Convict Cr., 1.

Remarks.—The many specimens of *Eutamias amoenus* at hand from California exhibit great individual variation, which tends to obscure the geographic trends. In many instances series referred to one race contain individuals having features characteristic of another race. For example, some specimens from Modoc County, considered singly and judged entirely on color characters, would be referred to the dark-colored race *ochraceus,* whereas others from the same region are pallid enough to be called *monoensis,* but the average characters of all the specimens in the series indicate that these populations as a whole represent the intermediate-colored subspecies *amoenus.*

Howell (1929:65) refers specimens from the Big Valley Mountains, Lassen County, a locality well within the range of *amoenus,* to the subspecies *ochra-*

ceus. I have not seen these nor any other specimens from the Big Valley Mountains, but certain individuals in the series of *amoenus* that I have examined from localities both north (Medicine Lake) and south (Mount Lassen) of there might easily be referred to the race *ochraceus.* The frequent occurrence of such apparent anomalies of geographical variation makes systematic work on this species unusually difficult and emphasizes the need for closer study of local environmental conditions.

The three Californian subspecies recognized here are based on average size and color characters that are unmistakably correlated with geographic distribution. Moreover, the major trends in geographic variation of the characters can be shown to correspond in general to geographic variation in certain environmental factors, namely, humidity and soil color.

The chief character used to distinguish the races, in this as well as in other chipmunk species, is degree of pigmentation of the fur. There is the usual trend from dark or saturate toward pallid coloration progressing interiorly from the humid coastal region. This character is best shown in the reddish color of the sides in summer pelage. The darkest-colored specimens I have seen are from Redcap Creek, at the extreme western end of the Salmon Mountains (in winter pelage), and from Blake Lookout, in the South Fork Mountains (in summer pelage). Specimens from localities farther east in the Salmon and Scott ranges are progressively paler; those from the Mount Eddy region are closely similar to specimens from the isolated population in the Yolla Bolly Mountains. A similar difference in color exists between specimens from the west end and those from the east end of the Siskiyou Mountains, but, perhaps because they are all in winter pelage, the difference is less pronounced. All these populations from the region west of the Sacramento and Shasta rivers have in common a darker coloration than other Californian populations of the species, and I have accordingly grouped them under the name *ochraceus.* Howell (1929:65) applied this name to specimens from the Siskiyou Mountains, but referred the more southern series to *amoenus* with the statement that they were intermediate between the two races.

The trend toward pallid coloration continues eastwardly across eastern Siskiyou County and Modoc County and southeastwardly along the Cascade–Sierra Nevadan divide. The specimens from localities south of the Feather River are the palest-colored and are grouped under the name *monoensis.* Two specimens from Mohawk are certainly referable to this race, and large series from Independence Lake and Cisco are intermediate between it and *amoenus.* The Cisco specimens are too darkened by soot to be of much value for comparisons of color. In general the more western populations of *monoensis* are darker than those from localities farther east. In the Lake Tahoe region the range extends a short distance down the west slope of the Sierra Nevada, and the specimens from this more densely timbered region are darker, hence closer to *amoenus,* than are those from the more arid eastern localities. Farther south, in the Mono Lake region, the species is restricted to the arid eastern slope, and the populations are all pale.

Specimens from the northeastern part of the state, referred to the subspecies *amoenus,* have less ochraceous color in the dorsal stripes, with the result

TABLE 2

Average and Extreme Measurements in Millimeters of Adults of *Eutamias amoenus* and *Eutamias panamintinus*

Total length	Head and body length	Tail length	Hind foot (dry)	Ear from crown (dry)	Condylo-basal length	Greatest length of skull	Zygomatic breadth	Cranial breadth	Cranial depth	Interorbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias amoenus ochraceus from head of Doggett Creek, Siskiyou Mountains, Siskiyou County														
7 males					8 males									
206 197–218	112 106–115	94 83–102	31.6 30.7–32.5	11.9 11.0–12.9	29.5 29.0–30.2	33.1 32.3–33.8	18.6 18.4–19.2	13.8 15.6–16.1	11.1 10.8–11.4	7.5 7.1–7.9	9.9 9.5–10.3	5.0 4.8–5.1	2.3 2.1–2.5	5.1 4.9–5.2
10 females					9 females									
213 204–221	120 113–127	93 79–99	31.8 29.7–32.8	11.3 10.0–13.3	30.0 29.4–30.6	33.4 32.6–33.9	18.9 18.5–19.4	15.9 15.5–16.4	11.0 10.8–11.1	7.4 7.1–7.5	9.9 9.5–10.1	5.0 4.7–5.2	2.2 1.9–2.3	5.2 5.1–5.4
Eutamias amoenus amoenus from northeastern Siskiyou and northwestern Modoc counties														
5 males					6 males									
195 190–202	115 109–119	80 77–83	31.5 30.4–33.8	10.0 8.8–11.1	29.1 28.7–29.4	32.5 32.1–32.9	18.2 17.8–18.5	15.3 15.0–15.5	10.7 10.4–11.0	7.7 7.4–7.9	10.0 9.8–10.6	4.6 4.3–5.1	2.1 1.9–2.5	4.9 4.7–5.0
10 females					9 females									
200 190–210	119 110–125	82 75–88	31.4 29.9–32.3	9.8 8.5–11.0	29.6 28.9–30.4	32.7 32.1–33.5	18.5 18.1–19.0	15.5 14.9–15.9	10.8 10.6–11.0	7.6 7.2–8.2	9.9 9.5–10.2	4.7 4.5–5.0	2.1 2.0–2.3	4.9 4.8–5.1

Eutamias amoenus monoensis from western Mono County

6 males					5 males									
190 188–193	109 106–112	81 76–83	30.2 29.0–31.1	10.1 9.6–11.1	28.9 28.3–29.1	32.2 31.8–32.5	17.9 17.7–18.2	15.4 15.1–15.7	10.7 10.3–10.9	7.7 7.5–8.1	9.9 9.6–10.8	4.6 4.4–4.8	2.2 2.1–2.3	5.0 4.8–5.1
5 females					3 females									
199 195–202	119 113–127	81 73–85	30.4 29.7–31.1	10.8 10.1–11.6	29.0 28.8–29.3	32.3 31.8–32.9	18.5 18.1–18.9	15.5 15.3–15.7	10.8 10.6–11.0	7.8 7.7–8.0	9.7 9.0–10.1	4.6 4.6–4.7	2.2 2.0–2.3	5.0 5.0–5.1

Eutamias panamintinus panamintinus from Providence Mountains, San Bernardino County

10 males					10 males									
206 197–211	117 109–124	89 83–95	29.7 28.4–31.1	10.5 9.6–11.2	30.1 29.7–30.8	33.8 33.1–34.4	18.5 18.1–19.0	15.8 15.4–16.2	11.0 10.5–11.4	7.5 7.1–7.8	10.1 9.6–10.8	4.9 4.8–5.0	2.3 2.0–2.6	5.1 4.9–5.3
5 females					6 females									
209 200–214	122 110–127	87 84–90	30.0 28.8–30.6	10.8 10.2–11.2	30.2 29.7–30.8	33.8 33.3–34.2	18.7 18.4–19.0	15.9 15.5–16.2	10.9 10.5–11.1	7.2 6.9–7.5	10.1 9.9–10.4	4.9 4.7–5.1	2.3 2.2–2.5	5.1 5.1–5.2

Eutamias panamintinus acrus from Kingston Range, San Bernardino County

4 males					3 males									
202 192–209	112 103–119	90 88–92	28.9 28.4–29.4	10.7 9.6–11.3	29.6 29.5–29.7	33.2 32.9–33.3	18.0 17.7–18.4	15.3 15.0–15.5	11.0 10.9–11.2	7.0 6.8–7.1	10.0 9.8–10.1	4.7 4.6–4.9	2.1 2.1–2.1	4.9 4.9–5.0
4 females					3 females									
200 196–205	111 109–112	90 85–96	29.9 29.0–30.5	10.3 9.6–11.1	29.8 29.0–30.5	33.3 32.5–34.0	18.3 17.9–18.5	15.5 15.0–15.7	10.8 10.5–11.1	7.1 6.9–7.3	10.0 9.4–10.4	4.8 4.6–5.0	2.2 2.2–2.3	5.1 5.0–5.2

that the alternating light and dark stripes are more sharply contrasted. The dark stripes are usually black and the light stripes gray or white, with the ochraceous color restricted to narrow transitional borders between them. This diminution in extent of ochraceous color is characteristic of the populations inhabiting the areas of igneous rock in the Mount Shasta, Mount Lassen, and Modoc regions. The range of the subspecies *amoenus* in California, as determined by this character, coincides closely with the distribution of dark-colored lavas. The Cascade Range, including Mount Shasta and Mount Lassen, is of volcanic origin, and a lava sheet extends eastward across Modoc and northern Lassen counties. The Siskiyou and Salmon mountain regions inhabited by *ochraceus* and the parts of the Sierra Nevada inhabited by *monoensis* are nonigneous, being characterized by metamorphic, lighter-colored granites.

The areas of exposed lava in the range of *amoenus* are generally small and scattered, and some of the intervening soil is derived from light-colored volcanic ash. There are numerous fairly recent lava flows on the lower slopes of Mount Shasta and in the Modoc Lava Beds. Two specimens in a series of nine from Mount Shasta are very dark colored; in this respect nearly identical with near topotypes of the race *Eutamias amoenus cratericus,* named by Blossom (1937:1) from black lavas in the Craters of the Moon National Monument, Butte County, Idaho. These are exceptional individuals, however; others in the same series and in other series from near-by localities are much paler. The failure of this region to develop a race as dark as *cratericus* may be due to the discontinuous distribution of the lava.

There are thus two types of color variation to be considered. The first, a trend or cline from saturate toward dilute (dark toward pale) ochraceous color areas, is correlated with geographic change in climatic "wetness" and runs through all the populations. The second, diminution in *extent* of the ochraceous color on the back, is correlated with the distribution of igneous rocks and is superimposed on the first. The dark-colored *ochraceus* is thus separated from the light-colored *monoensis* by the race *amoenus,* in which the amount of ochraceous color is reduced.

Eutamias panamintinus Merriam

Tamias panamintinus Merriam, 1893*b*:134.

Chipmunks of this species are small and brightly colored forms inhabiting piñon forests in the southwestern part of the Great Basin region. They are apparently more closely related to *Eutamias amoenus* than to any other species, but even this relationship is somewhat remote, and the morphological and habitat differences between *E. panamintinus* and *E. amoenus* are sufficiently great to preclude the possibility of intergradation. In its choice of habitat, *E. panamintinus* closely resembles the much larger *E. dorsalis,* and the ranges of these two species are complementary, approaching but not meeting in southern Nevada; they do not seem to be closely related.

Geographic distribution.—In California, east side of southern Sierra Nevada and desert ranges of southern Mono, Inyo, and northeastern San Bernardino counties (fig. 5). Outside California, desert ranges along southwestern

border of Nevada, from Sweetwater and Wabuska ranges, Mineral County, south to Potosi Mountain, Clark County (specimens in Mus. Vert. Zoöl. and D. R. Dickey Coll.).

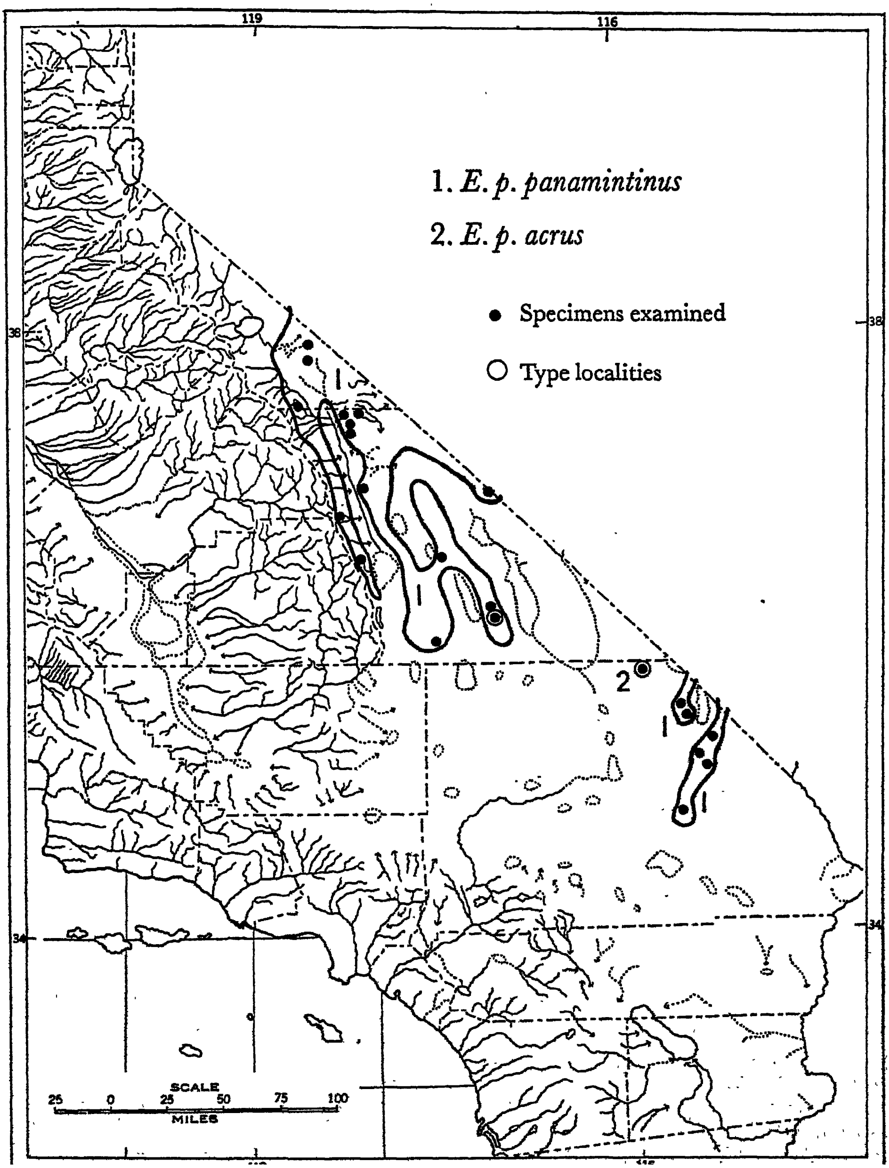


Fig. 5. Distribution of *Eutamias panamintinus* in California.

The zonal range of the species is restrictedly Upper Sonoran, coinciding closely with that of the forests of piñon. Altitude records are from 5500 to 9000 feet on the east slope of the Sierra Nevada, 5600 to 9000 feet in the White Mountains, 7500 to 9500 feet in the Inyo Mountains, 6000 to 9300 feet in the Panamint Mountains, 5327 to 6500 feet in the Argus Mountains, 4750 to 5500

feet on Kingston Peak, 5300 to 6300 feet on Clark Mountain and the Mescal Range, and 4100 to 5400 feet in the Providence Mountains. It probably reaches the summits of all these ranges except the Sierra Nevada and the White, Inyo, and Panamint mountains.

Habitat.—*Eutamias panamintinus* is closely restricted to the arid forests of piñon. On the ranges of medium elevation the piñon forest covers the summits and upper slopes; on the highest ranges, such as the Sierra Nevada and the White and Inyo mountains, it forms a distinct belt above which are sagebrush and mountain mahogany or Boreal Zone coniferous forests inhabited by other species of chipmunks. *E. panamintinus* is primarily a rock-dweller; in its habitat the soil cover is thin; fissured granite cliffs and ledges are abundant; and logs such as might otherwise serve as nesting and refuge places are small and disintegrate quickly through external weathering.

Eutamias panamintinus tolerates a hotter and more arid climate than does any other Californian species of *Eutamias*. Some of its low-zone biotic associates, at 5000 feet elevation in the Providence Mountains, are antelope ground squirrels (*Citellus leucurus*), desert sparrows (*Amphispiza bilineata*), collared lizards (*Crotaphytus collaris*), spotted toads (*Bufo punctatus*), and Joshua trees (*Yucca brevifolia*).

Characters.—Size small, slightly greater than in *Eutamias amoenus;* length of head and body averaging about 115 mm.; condylobasal length of skull averaging about 30.0 mm.; weight of adult males averaging about 50 grams. Tail length medium, averaging about 77 per cent of head and body length; feet moderately short, length of hind foot (dry) averaging about 26.0 per cent of head and body length. Ears short, rounded; length (from crown on dry skin) averaging about 9.3 per cent of head and body length.

Colors in general pale buff, with black areas greatly restricted. Crown of head light gray. Dark facial stripes greatly reduced, superciliary and ocular stripes narrow but well defined, submalar stripe usually only faintly indicated. Cheeks and light facial stripes light gray, nearly white, not suffused with ochraceous. Dark dorsal stripes, except median stripe, usually brown rather than black; outermost stripes scarcely distinguishable from color of sides. Inner and outer light dorsal stripes about equal in width, usually faintly washed with ochraceous. Underside of tail paler than sides in summer pelage; subterminal black area about 12 mm. anteroposteriorly. In winter pelage, fur unusually long and silky, colors yellowish, and markings inconspicuous.

Skull (pl. 6, *d*) unusually broad, especially in posterior part; zygomatic breadth equal to about 62 per cent of condylobasal length. Rostrum relatively narrow and deep. Brain case large, square-appearing, roof flattened in vicinity of frontoparietal suture, sides and posterior end nearly vertical. Zygomatic arches closely appressed to brain case in squamosal region, slanting toward median line anteriorly; zygomatic processes of squamosals more nearly vertical than horizontal as viewed from behind. Teeth relatively large; incisors moderately recurved; rows of cheek teeth nearly parallel.

Comparisons.—Characters in which *Eutamias panamintinus* differs from *E. amoenus* are given on page 83; from *E. quadrivittatus*, on page 97; and from *E. speciosus*, on page 104.

It differs from the species in the "*townsendii* group" (*townsendii, quadrimaculatus, sonomae,* and *merriami*) in smaller size, buffy rather than white tail edging, relatively broader brain case, and narrower rostrum.

Compared with the species *alpinus* and *minimus, panamintinus* is larger and, especially in summer pelage, more reddish, with a broader and more flattened brain case. The underside of the tail is more reddish and less yellowish centrally and has a shorter subterminal black area than in *alpinus;* the central area is broader and more reddish, less grayish, than in *minimus.*

Measurements.—See table 2, pages 88–89.

Subspecies.—The two races recognized differ chiefly as follows:

Size larger; colors paler; zygomata more flaring; rostrum longer and broader. Range of species (fig. 5) except Kingston Range . . . . *panamintinus* (p. 93)

Size smaller; colors darker; zygomata more appressed to skull; rostrum shorter and narrower. Restricted to Kingston Range, San Bernardino County . . . . *acrus* (p. 94)

Eutamias panamintinus panamintinus Merriam

Tamias panamintinus Merriam, 1893*b*:134 (original description); Allen, 1894:24; Trouessart, 1897:430; Elliot, 1901*a*:74, 1901*b*:487, 1905:90, 1907:151.

Eutamias panamintinus, Merriam, 1897:194; Miller and Rehn, 1901:43; Trouessart, 1904:332; Miller, 1912:312; Grinnell, 1913:350; Howell, 1922:184; Grinnell, 1923:322; A. B. Howell, 1924:34; Miller, 1924:203; Anthony, 1928:234; Howell, 1929:78.

Eutamias panamintus, Stephens, 1906:79.

Eutamias panamintinus panamintinus, Burt, 1931:298; Grinnell, 1933:128; Bole, 1938:245.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 27603/39702; male adult, skin and skull; vicinity of Hungry Bill's Ranch, about 5000 feet altitude, Panamint Mountains, Inyo County, California; April 3, 1891; collected by E. W. Nelson, original no. 723. (Merriam, 1893*b*:134; Grinnell, 1933:128.)

Geographic distribution.—In California, east side of Sierra Nevada from Rock Creek south to 5 mi. SW Olancha (Howell, 1929:79); high country at head of Owens Valley (Benton and Antelope Peak); White Mountains and Inyo Mountains, from Nevada state line south to Mazourka Canyon; Grapevine, Panamint, Coso, and Argus ranges; Clark Mountain and Mescal Range; Providence Mountains (including New York Mountains) from vicinity of Ivanpah south to Granite Mountains (fig. 5). Outside California, as described for the species.

The presence of this race across the state line at certain localities in Nevada indicates that it may also occur in California in the Sweetwater Range.

Characters and comparisons.—Size larger than in *acrus.* Colors paler; sides approaching Ochraceous Tawny; crown of head more grayish. Skull larger throughout; rostrum relatively longer and more massive, less pointed; brain case more prolonged posteriorly; zygomatic arches less appressed to skull.

Specimens examined.—A total of 199, from localities in California as follows: *Mono County:* Near Antelope Peak, 6500 ft., 5 mi. N Benton, 2; Benton, 5639 ft., 2; Rock Cr., 6200 ft., near Sherwin Hill, 21 mi. NW Bishop, 2. *Inyo County:* Silver Canyon, 7000–9000 ft., White Mts., 34; head Black Canyon, 9000 ft., White Mts., 4; 2½ mi. SE head Black Canyon, 8000 ft., White Mts., 8; Wyman Cr., 8300 ft., White Mts., 1; Roberts Ranch, 8250 ft., Wyman Cr., White Mts., 3; Mazourka Canyon, 7700–9500 ft., Inyo Mts., 19; Onion Valley, 8500 ft., Sierra Nevada, 4; Little Onion Valley, 7500 ft., Sierra Nevada, 2; Hockett Trail, 5500–7500 ft., vicinity of Carroll Cr., Sierra Nevada, 15; Hockett Trail, 8500 ft., near Cottonwood Cr., Sierra Nevada, 1; Little Cottonwood Cr., 9000 ft., Sierra Nevada, 1; Fall Canyon, 5600 ft., Grapevine Mts., 1; 3 mi. N Jackass Spring, 6000 ft., Panamint Mts., 1; 3 mi. NE Jackass Spring, 6300 ft., Panamint Mts., 6; 3 mi. E Jackass Spring, 6200–6500

ft., Panamint Mts., 12; Hanaupah Canyon, 7500–9300 ft., Panamint Mts., 16; Johnson Canyon, 6000–6500 ft., Panamint Mts., 4; Mountain Spring, 5327 ft., Argus Mts., 1; Mountain Springs Canyon, 5500–6600 ft., Argus Mts., 4. *San Bernardino County:* N. side Clark Mountain, 5400 ft., 1; SE. side Clark Mountain, 6300 ft., 3; 1½ mi. SW Mescal Spring, 5300–5500 ft., Mescal Range, 3; 5 mi. SW Ivanpah, 4500 ft., Providence Mts., 3; Cedar Canyon, 5000–5300 ft., Providence Mts., 32; 5 mi. NE Granite Well, 5400 ft., Providence Mts., 13; pass between Granite Mts. and Providence Mts., 4100 ft., 1.

Eutamias panamintinus acrus, new subspecies

Type.—Mus. Vert. Zoöl., no. 86164; male adult, skin and skull, in fresh summer pelage; 1.4 mi. SE Horse Spring, 5000 feet altitude, Kingston Range, northeastern San Bernardino County, California; June 9, 1939; collected by Ward C. Russell, original no. 6667.

Geographic distribution.—Restricted to Kingston Range, in northeastern San Bernardino County, California (fig. 5). Specimens have been collected only in the vicinity of Horse Spring, on the northeastern side of the range. The area of suitable habitat available in the Kingston Range is about 40 square miles; it is entirely surrounded by Lower Sonoran desert that is not habitable by any species of *Eutamias*.

Characters and comparisons.—Small for a member of the species *panamintinus* (see measurements). Color in general averaging darker than in subspecies *panamintinus;* color of sides approaching Mikado Brown. Skull smaller than in subspecies *panamintinus*, except in breadth and depth of brain case; rostrum shorter, narrower, and more pointed; interorbital breadth less; brain case less prolonged posteriorly; zygomata more appressed to skull.

The smaller size of all parts of the skull except the brain case in *acrus* as compared with *panamintinus* causes the brain case of *acrus* to appear larger and accentuates the shortness of the rostrum and the appressed condition of the zygomata. The darker color of *acrus*, without the accompanying cranial differences, would be scarcely sufficient to separate it as a distinct subspecies, although the specimens from the Kingston Range average darker than any other series of *E. panamintinus* that I have examined.

Specimens examined.—A total of 14, from the following localities in the Kingston Range, San Bernardino County, California: Horse Spring, 4700–4750 ft., 6; 1 mi. E Horse Spring, 4750 ft., 1; 1 mi. S Horse Spring, 5500 ft., 1; 1.4 mi. SE Horse Spring (type locality), 1; 2 mi. SW Horse Spring, 5300–5500 ft., 5.

Remarks.—The species exhibits relatively little geographic variation over its broad range. This condition may result from the restricted habitat it occupies and the consequent uniformity of environmental conditions. Specimens in the bright summer pelage are at hand in sufficient numbers and from enough localities to indicate that trends of geographical variation in color are slight. Certain populations are characteristically paler, whereas certain others are darker, than the intermediate "typical" populations. Most of these variants are less well defined than those characterizing the subspecies recognized in this paper.

Five specimens in fresh summer pelage from the Panamint Mountains represent typical *panamintinus*. Two of these are from the type locality, Johnson Canyon; three are from 35 miles to the northwest, near Jackass Spring. The Panamint Mountains lie near the geographical center of the area over which the species is distributed, and it so happens that in coloration specimens from this region are near the average for the species as a whole. Slightly paler populations occur in the Wabuska and Sweetwater ranges in Mineral County, Nevada, and possibly extend into California in northern Mono County. The other specimens are either similar to the Panamint Mountains series or darker,

than it. The darkest-colored series, described above under the name *acrus*, came from the Kingston Range in northeastern San Bernardino County.

Cranial characters likewise vary only slightly. The single well-marked and constant divergence from typical *panamintinus* is found in the isolated population of small individuals of the race *acrus*, in which the brain case is as large as in *panamintinus* whereas other parts of the skull are smaller.

It is perhaps significant that *acrus*, the only clearly differentiated population in the species, is restricted in numbers and occupies a small and completely isolated range. There may be other similarly isolated and well-differentiated populations on some of the smaller mountain ranges in southeastern California and southwestern Nevada from which specimens have not been collected. A single specimen in the Museum of Vertebrate Zoölogy, no. 70254, from Lone Mountain, an isolated peak about 15 miles west of Tonopah, Esmeralda County, Nevada, is even smaller than the average for *acrus*. However, it lacks the relatively large brain case and appressed zygomata of that race, in this respect resembling *panamintinus*. The skin, in worn winter pelage, seems nearest *panamintinus*, to which race I have referred the specimen pending further knowledge of this population.

Examination of the series (except the type specimen) on which Burt (1931: 298–299) based the name *Eutamias panamintinus juniperus* and additional recently collected specimens from the vicinity of the Charleston Mountains, Clark County, Nevada, reveals only slight average differences from typical *panamintinus*. As these are no greater than the differences between other series in the subspecies, I have considered *juniperus* a synonym of *E. p. panamintinus*.

Eutamias quadrivittatus Say

Sciurus quadrivittatus Say, 1823:45.

Eutamias quadrivittatus is closely related to the following species, which occupy complementary ranges in western North America: *E. ruficaudus* and *E. umbrinus* in the northern Rocky Mountains, *E. adsitus* in the Beaver Mountains of Utah and the Kaibab Plateau of northwestern Arizona, *E. palmeri* on Charleston Peak in southern Nevada, *E. speciosus* in the Sierra Nevada and the high mountains of southern California, *E. cinereicollis* in the mountains of central Arizona and southern New Mexico, and *E. bulleri* in the highlands of central Mexico. Howell (1929:79–105) has included all these species in the "*Eutamias quadrivittatus* group."

Geographic distribution.—In California, in three isolated areas: near crest of Sierra Nevada, from Mammoth Pass, Mono County, south to Cirque Peak, Inyo and Tulare counties; White Mountains, from Nevada state line in Mono County south to head of Black Canyon, Inyo County; Inyo Mountains, Inyo County (fig. 6). Outside California, this species occurs in the higher parts of the central Rocky Mountains and the Great Basin ranges: north to the Ruby Mountains in Nevada, the Fish Lake Plateau in Utah, and Estes Park in Colorado; south to the Sheep Mountains in Nevada, and to northeastern Arizona and central New Mexico. Being restricted to high elevations, the species is discontinuously distributed over its general range and inhabits Boreal "islands" cut off from one another by surrounding grasslands and deserts.

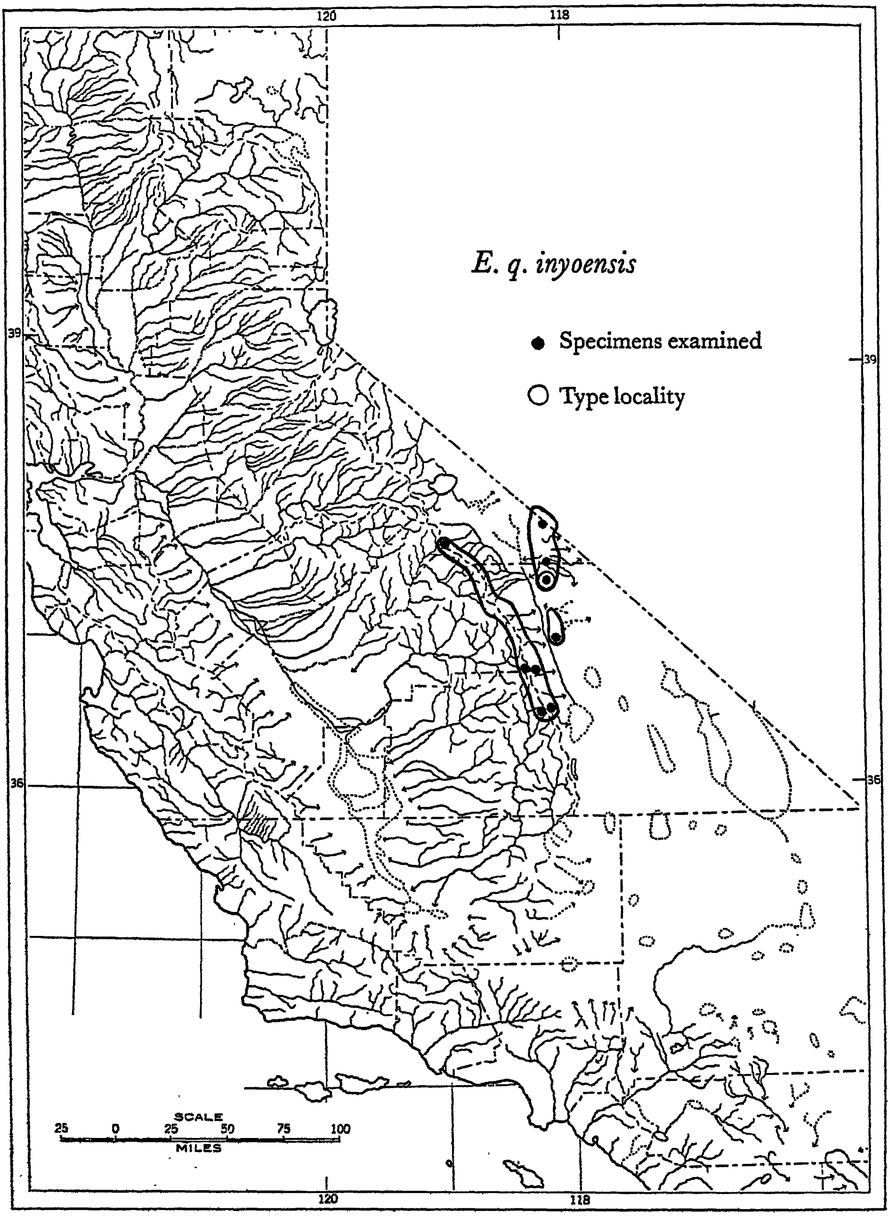


Fig. 6. Distribution of *Eutamias quadrivittatus* in California.

This species, in California, is restricted mainly to the slopes near timber line, occurring down to elevations as low as 9200 feet (McCloud Camp) in the White Mountains, 8400 feet (Mazourka Canyon) in the Inyo Mountains, and 7500 feet (Little Onion Valley, west of Independence) on the east slope of the Sierra Nevada. It does not range far below the summit on the west slope of the Sierra Nevada, having been taken there at only two places, Bullfrog Lake, 10,600 feet, and on Cirque Peak, at 10,500 feet. The highest elevation at which

specimens have been collected is 11,000 feet, at Cottonwood Lakes, east of Cirque Peak.

Habitat.—Exposed slopes and ridges near timber line, in the open stands pine, white-bark pine, and foxtail pine, and in the White and Inyo mountains, of stunted-appearing white pines, which in the Sierra Nevada include limber limber pine and bristle-cone pine. Closely restricted to the vicinity of trees, on which it depends largely for refuge places, and which are surrounded in the White Mountains by extensive tracts of sagebrush inhabited by *Eutamias minimus* and in the Sierra Nevada by cliffs and talus areas inhabited by *E. alpinus*. Does not occur in the Sierran forests of lodgepole pine inhabited by *E. speciosus* nor in the piñon belt inhabited by *E. panamintinus.*

Characters.—Size medium; length of head and body averaging about 125 mm.; condylobasal length of skull averaging about 32.0 mm.; weight of adult males averaging about 56 grams. Tail length medium, averaging about 75 per cent of head and body length. Feet moderately long; length of hind foot (dry) averaging about 26 per cent of head and body length. Ears short, averaging (from crown on dry skin) about 8.5 per cent of head and body length.

Colors generally pale, with black areas restricted but well defined; crown of head and shoulders gray; sides approaching Ochraceous-Tawny. Dark facial stripes mainly brown; submalar stripe lacking black center and nearly obsolete anteriorly. Dorsal stripes sharply contrasting; median stripe black throughout its length; inner light stripes gray; outer light stripes white and conspicuous, though but little broader than inner pair. Subterminal black area on underside of tail restricted, 10 to 12 mm. anteroposteriorly.

Skull (pl. 6, *e*) moderately broad; zygomatic breadth averaging about 61 per cent of condylobasal length. Dorsal outline strongly arched in lateral view. Zygomatic arches moderately appressed to skull; outer borders of temporal parts nearly straight and parallel to main axis of skull. Rostrum narrow, appearing elevated because of long upper incisors. Upper incisors long, slender, and little recurved; greatest curvature of each forming arc of circle having radius of about 5.7 mm. Upper rows of cheek teeth slightly bowed, their inner borders nearly parallel.

Comparisons.—*Eutamias quadrivittatus* may be distinguished easily by its medium size from all other Californian chipmunks except those of the species *amoenus, panamintinus,* and *speciosus.* It is larger than the species *alpinus* and *minimus* and smaller than the species *townsendii, quadrimaculatus, sonomae,* and *merriami* (see table of comparative measurements, p. 138). From the larger species it differs also in a buffy, rather than white, tail edging.

It differs from *Eutamias amoenus* in larger size, grayer head and shoulders, narrower inner light dorsal stripes, less ochraceous suffusion over light facial stripes and underparts, and more massive skull with relatively narrower brain case, more elevated rostrum, longer upper incisors, and more nearly parallel zygomatic arches.

It differs from *Eutamias panamintinus* in slightly greater size, grayer shoulders, more contrasting dorsal stripes (dark stripes more solidly black, light stripes less reddish), narrower and more rounded brain case, longer upper incisors, larger cheek teeth, and more nearly parallel zygomatic arches.

From *Eutamias speciosus,* with which it was previously considered conspecific, *E. quadrivittatus* differs only slightly in size, being larger. Other differences are more pronounced. It has shorter ears and a slightly longer tail; its colors are paler, with light rather than dark elements in the color pattern predominating; its shoulders and crown of head are gray rather than brown, as in *speciosus.* Its dark facial stripes are paler, the submalar stripe lacking a black center below the eye, and the ocular stripe being black only immediately adjacent to the eye. Its inner pair of light dorsal stripes is grayer and its outer pair whiter, neither pair being heavily washed with ochraceous, as in *speciosus.* The subterminal black area on the underside of its tail is more restricted, being about 10 mm. anteroposteriorly, as compared with about 20 mm. in *speciosus.* The skull of *quadrivittatus* is longer and narrower except in the interorbital region. The upper incisors are longer and less recurved, their outer borders forming an arc of a circle having a radius of about 5.7 mm., as

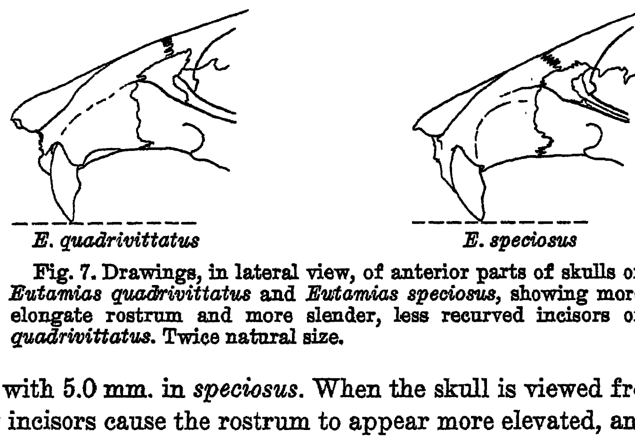


Fig. 7. Drawings, in lateral view, of anterior parts of skulls of *Eutamias quadrivittatus* and *Eutamias speciosus,* showing more elongate rostrum and more slender, less recurved incisors of *quadrivittatus.* Twice natural size.

compared with 5.0 mm. in *speciosus.* When the skull is viewed from the side, the longer incisors cause the rostrum to appear more elevated, and a perpendicular line through the posterior border of the alveolus would fall posterior rather than anterior to the tip of the incisor (fig. 7). Correlated with the more "open-mouthed" condition resulting from the longer incisors, the anterior cheek teeth project farther from the level of the palate. The auditory bullae are larger. The outer borders of the zygomatic arches are straighter and more nearly parallel, not converging anteriorly as much as in *speciosus.*

Measurements.—See table 3, pages 100–101.

Subspecies.—Only one subspecies of *Eutamias quadrivittatus* occurs in California.

Eutamias quadrivittatus inyoensis Merriam

Eutamias speciosus inyoensis Merriam, 1897:202 and 208 (original description); Trouessart, 1899:1312; Miller and Rehn, 1901:45; Stephens, 1906:81; Miller, 1912:34; Grinnell, 1913:351; Howell, 1922:184; Grinnell, 1923:322; A. B. Howell, 1924:35; Miller, 1924:205; Anthony, 1928:299.

Eutamias speciosus, Merriam, 1897:202 (part).

Tamias callipeplus inyoensis, Elliot, 1901*a*:73, 1901*b*:487.

Eutamias callipeplus inyoensis, Trouessart, 1904:332.

Tamias speciosus inyoensis, Elliot, 1905:89, 1907:149.

Eutamias speciosus speciosus, Grinnell, 1913:350 (part).

Eutamias quadrivittatus inyoensis, Howell, 1929:84; Burt, 1931:299; Grinnell,

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 29387/41462; male adult, skin and skull; near head of Black Canyon, about 9000 feet altitude, White Mountains, Inyo County, California; July 7, 1891; collected by E. W. Nelson, original no. 1069. (Merriam, 1897:208; Grinnell, 1933:129.)

Geographic distribution.—In California, as given above for the species. Outside California, this subspecies recurs on the higher slopes of the Great Basin ranges of Nevada and central and western Utah (Howell, 1929:86, and additional specimens in Mus. Vert. Zoöl.).

Specimens examined.—A total of 85, from the following localities in California: *Mono County:* Mammoth Pass, 9800 ft., Sierra Nevada, 1 (D. R. Dickey); Indian Cr., 9500 ft., White Mts., 2; McCloud Camp, 9500 ft., White Mts., 9 (D. R. Dickey); Poison Cr., 9500–9900 ft., White Mts., 7 (D. R. Dickey, 4); vicinity of Big Prospector Meadow, 10,000–10,350 ft., White Mts., 23 (D. R. Dickey, 8). *Inyo County:* Ridge east of head Black Canyon, 10,000 ft., White Mts., 6; Mazourka Canyon, 8400 ft., Inyo Mts., 1; Kearsarge Pass, 9500–10,500 ft., Sierra Nevada, 9; Onion Valley, 8500 ft., Sierra Nevada, 15; Little Onion Valley, 7500 ft., Sierra Nevada, 2; Hockett Trail, south of Carroll Cr., 8500 ft., Sierra Nevada, 2; Cottonwood Lakes, 11,000 ft., Sierra Nevada, 4. *Fresno County:* Bullfrog Lake, 10,600 ft., Sierra Nevada, 3. *Tulare County:* S. slope Cirque Peak, 10,500 ft., Sierra Nevada, 1.

Remarks.—The present treatment of *inyoensis* as a subspecies of *Eutamias quadrivittatus* is based on Howell's (1929:85) statement that specimens from the Henry Mountains of southeastern Utah are intermediate between *inyoensis* and *quadrivittatus*.

The race *inyoensis* was originally named by Merriam as a subspecies of *Eutamias speciosus* and has heretofore been thought to intergrade with that species along the crest of the Sierra Nevada west of Owens Valley. However, I have found that the two species, *quadrivittatus* and *speciosus*, occur together without intergrading, and that each is restricted to a characteristic habitat. A check of collectors' field notes pertaining to specimens from this region, now in the Museum of Vertebrate Zoölogy, reveals that *quadrivittatus* was taken only in the vicinity of open forests of stunted limber pine and white-bark pine on exposed and well-drained ridges and slopes near timber line, whereas *speciosus* was taken only in or near the dense stands of lodgepole pine in the damper and more sheltered basins. None of the specimens of either species shows intermediate characters that would indicate intergradation.

Near the headwaters of the south fork of the Kings River *speciosus* has been taken as high as 9600 feet altitude on Bubbs Creek, and *quadrivittatus* 1000 feet higher at Bullfrog Lake. In the vicinity of Cirque Peak, a few miles south of Mount Whitney, 16 specimens collected at Whitney Meadow, 9800 feet, on the west slope, and 4 at Little Cottonwood Creek, 9500 feet, on the east slope, are *speciosus*, whereas one taken at 10,500 feet on the south side of Cirque Peak proved to be *quadrivittatus*. Of 5 specimens taken at Cottonwood Lakes, 11,000 feet, near which both limber pine and lodgepole pine associations occur, 4 are *quadrivittatus* and one is *speciosus*.

A. B. Howell (1924:34–35) has already pointed out that the same mutual exclusiveness of characters and habitat is exhibited in the vicinity of Mammoth, Mono County, where he took a specimen of *inyoensis* from among white-bark pines near timber line (9800 feet), and others of *frater*, a subspecies of *speciosus*, from among lodgepole pines between 7900 and 9000 feet.

Although the populations of the Sierra Nevada, the White Mountains, and the Inyo Mountains are completely isolated from one another geographically, they are not distinguishable by structural or color differences.

TABLE 3

AVERAGE AND EXTREME MEASUREMENTS IN MILLIMETERS OF ADULTS OF *Eutamias quadrivittatus* AND *Eutamias speciosus*

Total length	Head and body length	Tail length	Hind foot (dry)	Ear from crown (dry)	Condylo-basal length	Greatest length of skull	Zygomatic breadth	Cranial breadth	Cranial depth	Interorbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias quadrivittatus inyoensis from White Mountains, Mono County														
8 males					8 males									
217 210–220	123 117–126	92 86–95	31.6 31.0–32.4	10.8 10.2–11.9	31.7 31.0–32.3	35.2 34.0–36.0	19.3 18.7–19.8	16.0 15.6–16.4	11.3 11.0–11.8	8.0 7.6–8.4	11.0 9.9–11.4	5.2 5.1–5.4	2.3 2.2–2.5	5.5 5.3–5.6
10 females					12 females									
220 215–225	127 121–130	93 90–100	32.1 30.8–33.1	10.5 10.0–11.1	32.0 31.3–32.6	35.6 35.1–36.1	19.6 18.6–20.1	16.1 15.4–16.5	11.3 10.9–11.7	7.8 7.4–8.2	11.1 10.7–11.7	5.3 5.0–5.5	2.5 2.2–2.8	5.4 5.3–5.6
Eutamias speciosus frater from southern Tuolumne County														
10 males					10 males									
211 204–218	122 116–128	88 80–95	32.5 31.1–33.8	12. 5 11.3–13.2	31.0 30.2–31.5	34.6 33.8–35.2	19.2 18.7–19.5	15.8 15.3–16.2	11.1 10.8–11.5	7.8 7.1–8.2	11.0 10.2–11.6	5.0 4.8–5.2	2.6 2.3–3.0	5.4 5.1–5.6
10 females					10 females									
210 197–216	123 114–132	87 80–92	33.0 32.1–33.8	12.1 11.5–13.1	31.0 30.4–31.7	34.8 34.0–35.4	19.1 18.7–19.4	15.8 15.5–16.2	11.2 10.9–11.9	7.7 7.3–8.0	11.0 10.5–11.6	5.2 5.0–5.4	2.4 2.0–2.6	5.4 5.3–5.6

Eutamias speciosus sequoiensis from Whitney Creek and Whitney Meadow, Tulare County

8 males					5 males									
212 205–222	121 115–123	91 83–100	32.3 31.7–33.0	11.8 11.0–12.7	31.3 31.0–31.8	35.1 34.3–35.9	19.2 18.8–19.5	15.7 15.1–16.1	11.3 11.1–11.5	8.2 8.0–8.6	11.0 10.3–11.4	5.1 5.0–5.3	2.3 2.0–2.4	5.3 5.2–5.5
11 females					8 females									
219 210–229	124 121–130	95 87–102	32.4 31.0–33.4	12.1 11.0–13.1	31.3 30.5–32.2	35.0 34.2–35.9	19.4 19.2–19.7	15.9 15.7–16.2	11.4 11.2–11.7	8.0 7.8–8.3	10.9 10.2–11.5	5.0 4.8–5.2	2.4 2.3–2.6	5.4 5.3–5.6

Eutamias speciosus speciosus from Bluff Lake, San Bernardino Mountains, San Bernardino County

13 males					8 males									
209 200–216	126 115–132	83 79–90	31.8 30.9–33.4	12.0 10.6–14.1	31.3 30.6–32.0	34.8 34.3–35.1	19.0 18.8–19.2	15.6 15.4–15.8	11.2 10.9–11.6	7.9 7.4–8.2	10.8 10.3–11.9	5.1 5.0–5.2	2.3 2.0–2.6	5.2 5.1–5.4
17 females					10 females									
210 200–219	128 117–144	83 67–90	31.5 30.1–33.0	12.0 11.1–13.8	31.4 30.3–32.2	34.9 33.5–35.8	19.1 18.4–19.7	15.7 15.2–15.9	11.2 10.7–11.8	7.9 7.6–8.0	10.8 10.3–11.1	5.1 4.9–5.4	2.3 2.1–2.5	5.3 5.1–5.6

Eutamias speciosus callipeplus from Mount Pinos, Ventura County

5 males					5 males									
211 206–218	124 120–128	88 86–91	33.0 32.5–33.5	11.8 11.4–12.2	31.5 31.2–32.0	35.2 35.1–35.5	18.8 18.8–18.9	15.5 15.4–15.8	11.4 11.3–11.5	8.0 7.6–8.2	11.3 11.1–11.7	5.2 5.1–5.3	2.6 2.4–2.7	5.4 5.3–5.5
15 females					15 females									
217 208–228	128 123–133	89 82–99	32.7 32.0–34.0	12.3 11.5–13.0	31.8 31.0–32.3	35.5 34.6–36.1	19.0 18.6–19.4	15.7 15.5–15.9	11.5 11.0–11.9	8.1 7.7–8.7	11.5 11.0–11.9	5.1 4.9–5.4	2.5 2.3–2.9	5.5 5.3–5.6

Eutamias speciosus Allen

Tamias speciosus Allen, 1890:60 and 86.

This species is the westernmost representative of the *Eutamias quadrivittatus* group. The only other Californian species closely related to it is *E. quadrivittatus.*

Geographic distribution.—In California, Sierra Nevada and its major spurs from vicinity of Mount Lassen south on both east and west slopes to vicinity of Mammoth Pass, and on west slope only (except near head of Little Cottonwood Creek, Inyo County) to southern Tulare County; as isolated populations on summits of Piute Mountains, Mount Pinos, San Gabriel Mountains, San Bernardino Mountains, and San Jacinto Mountains (fig. 8). Outside California, only in vicinity of Lake Tahoe, Nevada.

The species is restricted chiefly to the Canadian Zone, locally invading the adjacent borders of the Transition and Hudsonian zones. Its known altitudinal range in the Mount Lassen region is from 5200 feet (2 miles east of Mineral) to 8500 feet (Lake Helen), in the Yosemite region from 6100 feet (near Gentry's) to 10,700 feet (head of Lyell Canyon), and in the Mount Whitney region from 5000 feet (South Fork of Kings River) to 11,000 feet (Cottonwood Lakes). In the isolated mountains of southern California it ranges from the summits down at least to 6700 feet in the Piute Mountains, 8000 feet on Mount Pinos, 6500 feet in the San Bernardino Mountains, and 8000 feet in the San Jacinto Mountains. The lowest elevation at which specimens have been collected is 4500 feet, at Chilkoot Camp Ground, near Bass Lake, Madera County.

The range of *Eutamias speciosus* closely parallels that described by Sudworth (1908:52–53) for lodgepole pine south of the Pit River.

Habitat.—Coniferous forests, usually of the interrupted type adjacent to chaparral areas, but sometimes in solid stands of trees. Nearly always associated with lodgepole pine; also with red fir, Jeffrey pine, and chinquapin. Frequently seen in trees, up which it regularly takes refuge when disturbed. Forages over forest floors, in chaparral, and about borders of meadows, but never ventures far from trees.

Characters.—Size medium; length of head and body averaging about 125 mm.; condylobasal length of skull averaging about 31.3 mm.; weight of adult males averaging about 59 grams. Tail short, averaging about 70 per cent of head and body length. Feet moderately long; length of hind foot (on dry skin) averaging about 26 per cent of head and body length; toes slender. Ears long, averaging (from crown on dry skin) about 9.8 per cent of head and body length.

Color generally bright, with light and dark elements of color pattern strongly contrasting. Crown of head brown, grizzled with gray; sides varying from Ochraceous-Tawny to Sayal Brown in summer pelage. Dark facial stripes black, bordered with brown; submalar stripe black centrally below eye. Dorsal stripes sharply contrasting; median stripe black, usually fading to brown over the shoulder region; inner light stripes washed with ochraceous; outer

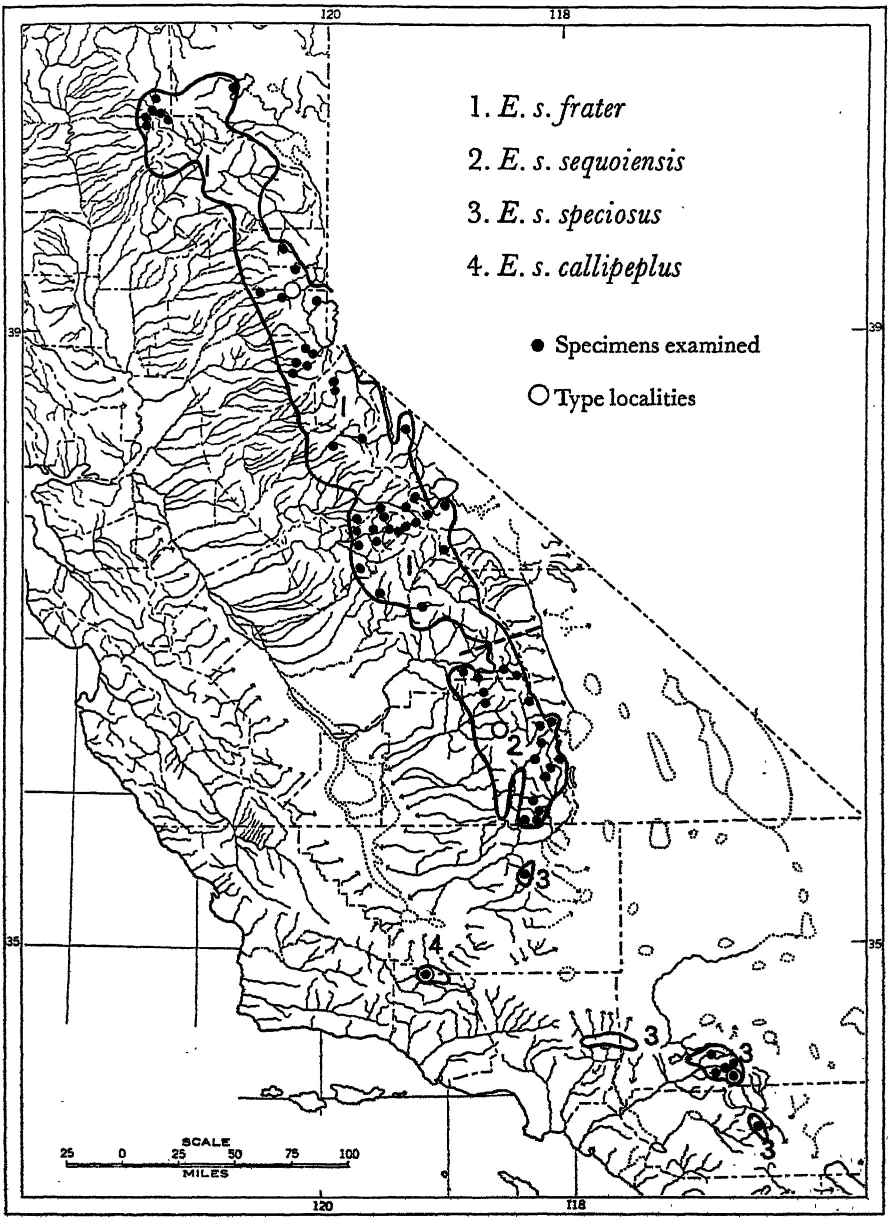


Fig. 8. Distribution of *Eutamias speciosus* in California.

light stripes broad, white, and strikingly conspicuous. Subterminal black area on underside of tail extensive, 13 to 20 mm. anteroposteriorly.

Skull moderately broad; zygomatic breadth averaging about 61 per cent of condylobasal length. Dorsal outline strongly arched in lateral view. Zygomatic arches moderately appressed to skull; outer borders of temporal parts bowed and sloping inward anteriorly. Rostrum short, broad at base, and narrowing rapidly anteriorly. Interorbital region broad; interorbital breadth

averaging about 25.4 per cent of condylobasal length. Upper incisors short and sharply recurved; curvature of outer border of each incisor forming arc of circle with radius of about 5.0 mm. Inner margins of upper rows of cheek teeth divergent anteriorly.

Comparisons.—*Eutamias speciosus* is approximately the same size as *E. quadrivittatus* (see table of comparative measurements, pp. 100, 101, 138), and, like it, may be distinguished from other Californian species of *Eutamias*, except *amoenus* and *panamintinus*, by size alone.

For characters distinguishing *speciosus* from *quadrivittatus*, see page 98.

E. speciosus differs from *E. amoenus* in greater size, longer and narrower-appearing ears, and more sharply contrasting light and dark stripes. In *speciosus* the inner pair of light dorsal stripes is narrower and the outer pair of light stripes, though not always broader, is more conspicuous; the light facial stripes are less heavily washed with ochraceous, and the dark facial stripes are usually blacker. The skull of *speciosus* is more massive, with a less pointed rostrum and larger incisive foramina.

Compared with *panamintinus*, *speciosus* is larger and has more pointed ears, more black in the dark facial and dorsal stripes, more ochraceous wash over the light stripes and underparts, and a broader subterminal black band across the underside of the tail. The skull of *speciosus* is relatively narrower in general, but has a broader and less pointed rostrum; the roof of the brain case is less flattened; the upper rows of cheek teeth diverge more anteriorly.

Measurements.—See table 3, pages 100–101.

Subspecies.—Of the four subspecies of *Eutamias speciosus*, one is well marked and easily distinguishable from the remaining three, which differ only slightly from one another. Variations in color, perhaps because they are more easily detected than are cranial variations and those involving proportions of appendages, are the most satisfactory for describing and recognizing the subspecies. Skulls are remarkably uniform in all the races; slight average differences noted are little more than variations in relative breadth. The following key indicates the chief characters and the general ranges of the subspecies:

1. Sides more reddish; outer light dorsal stripes narrower; skull broader. Northern and central Sierra Nevada . . . . *frater* (p. 104)

1′. Sides more brownish; outer light dorsal stripes broader; skull narrower.

  2. Black subterminal area on underside of tail more than 15 mm. anteroposteriorly.

    3. Sides of body and underside of tail paler. Southern Sierra Nevada *sequoiensis* (p. 106)

    3′. Sides of body and underside of tail darker. Piute, San Gabriel, San Bernardino, and San Jacinto mountains . . . . *speciosus* (p. 106)

  2′. Black subterminal area on underside of tail less than 15 mm. anteroposteriorly. Mount Pinos . . . . *callipeplus* (p. 107)

Eutamias speciosus frater Allen

Tamias frater Allen, 1890:60 and 88 (original description); Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:431; Elliot, 1898:195, 1901*a*:73, 1901*b*:487, 1905:90, 1907:150.

Eutamias speciosus frater, Merriam, 1897:202; Stephens, 1906:82; Grinnell, 1913:350; Swarth, 1919:404; Howell, 1922:184; Grinnell, 1923:322; A. B. Howell,

1924:34; Grinnell and Storer, 1924:176; Miller, 1924:205; Anthony, 1928:229; Grinnell, Dixon, and Linsdale, 1930:487.

Eutamias frater, Miller and Rehn, 1901:41; Trouessart, 1904:332; Miller, 1912:309.

Eutamias quadrivittatus frater, Howell, 1929:86; Grinnell, 1933:129; Howell, 1938: 48.

Type.—Amer. Mus. Nat. Hist., no. 1308/571; female adult, skin and skull; Donner, Placer County, California; June 7, 1886; collected by C. A. Allen. (Allen, 1890:88; Howell, 1929:86.)

Geographic distribution.—Northern and central Sierra Nevada, from Mount Lassen and Eagle Lake south to Huntington Lake, Fresno County (fig. 8).

Westernmost localities of occurrence, from north to south: 2 miles east of Mineral, Chaparral (Howell, 1929:87), Cisco, Kyburz, Crane Flat, Devils Peak, and Chilkoot Camp Ground (near Bass Lake). Easternmost localities in California: Spalding's, Independence Lake, 2½ miles north of Carnelian Bay, Swager Creek, Mono Craters, and near Mammoth.

The northernmost localities—those from the Mount Lassen region—may represent an isolated part of the range of the subspecies. No specimens are at hand, nor are there any published records of occurrence, indicating that these high-zone chipmunks now range continuously across the Feather River gap.

Nevadan records of this race include specimens seen by me from Incline Creek and 3 miles south of Mount Rose, Washoe County, and published records (Howell, 1929:87) for Glenbrook, Genoa, and Edgewood, all in Douglas County.

Characters and comparisons.—Color more reddish than in other subspecies. Light and dark dorsal stripes more sharply contrasting, dark stripes more nearly solid black, with outer light stripes narrower. Sides of body and underside of tail paler. Subterminal black area on underside of tail about as in *callipeplus*, more restricted than in *sequoiensis* and *speciosus*. Skull slightly broader than in other subspecies (average zygomatic breadth about 62 per cent, rather than about 60 or 61 per cent, of average condylobasal length); zygomata appearing more smoothly arched and less appressed to skull anteriorly.

Specimens examined.—A total of 302, from the following localities in California: *Shasta County:* Manzanita Lake, 6000 ft., Mt. Lassen, 5; Lake Helen, 8500 ft., Mt. Lassen, 2; Warner Cr., 6600–8300 ft., Mt. Lassen, 32. *Lassen County:* Spalding's, W. side Eagle Lake, 15; Eagle Lake, 2. *Tehama County:* Lassen Road, 6800 ft., 2 mi. W Black Butte, 2; Summit Cr., 5200 ft., 2 mi. E Mineral, 2. *Plumas County:* Hot Spring Valley, Mt. Lassen, 13. *Sierra County:* Campbell's Hot Springs, 5200 ft., 1½ mi. SE Sierraville, 1. *Nevada County:* Independence Lake, 3. *Placer County:* Cisco, 6000 ft., 67; Onion Cr., 6100 ft., 3½ mi. S Soda Springs, 1; 2½ mi. N Carnelian Bay, 7100 ft., 1. *Placer County* or *Eldorado County:* "Lake Tahoe Valley," 1. *Eldorado County:* Forni's Cabin, 1; near Upper Velma Lake, 7800 ft., 1; China Flat, 7800 ft., Rockbound Valley, 1; Gilmore Lake, Mt. Tallac, 4; Susie (or Suzy) Lake, 1; Lake of the Woods, 8200 ft., 2; Wrights Lake, 2; Kyburz Station, 1; Echo, 1. *Alpine County:* Hope Valley, 1; Faith Valley, 7470 ft., 2; W. side Sonora Pass, 9500 ft., 1. *Tuolumne County:* ½ mi. N Mill Creek Public Camp, 6500 ft., 1; Aspen Valley, 6400 ft., 9; vicinity of Ten Lakes, 9200–9700 ft., 3; Tuolumne R., 6400–7300 ft., 3; 1 mi. E Mattie Lake, 9500 ft., 1; vicinity of Glen Aulin, 7700–8000 ft., Tuolumne R., 6; 3 mi. N Tuolumne Meadows, 10,000 ft., 1; Tuolumne Meadows, 8500–9000 ft., 17; Lyell Canyon, 9000–10,700 ft., 12. *Mariposa County:* Vicinity of Crane Flat, 6300–6500 ft., 3; Big Oak Flat Road, 6100–6300 ft., near Gentry's, 2; E. fork Indian Canyon, 7300 ft., 2; vicinity of Porcupine Flat, 8100 ft., 18; Tioga Road, 8400 ft., near Mt. Hoffman, 2; Lake Tenaya, 8100 ft., 1; Echo Cr. basin, 7500 ft., 1; Fletcher Cr., 10,300 ft., 1; Cloud's Rest, 9600 ft., 1; Sunrise Cr., 8100 ft., 1; Yosemite Cr., 6500–6600 ft., 2; vicinity of Yosemite Point, 7000–7300 ft., 2; vicinity of Chinquapin, 6800–7500 ft., 3; near Mono Meadow, 6300–7400 ft., 8; Devils Peak, 6500 ft., near Fish Camp, 3; vicinity of Merced Lake, 7200–7500 ft., 8; McClure Fork Merced R., 9300–9700 ft., 3. *Mono County:* Swager Cr., 7600 ft., Sweetwater Range, 1; Warren Fork of Leevining Cr., 9700 ft., 1; Walker Lake, 8000 ft., 5; Mono Craters, 8000 ft., 1; near Pine City, 9000 ft., near Mammoth, 2. *Madera County:* Chilkoot Camp Ground, 4500 ft., near Bass Lake, 2 (Hooper Foundation Coll.). *Fresno County:* Huntington Lake, 7000 ft., 8; Cascada, 3.

Eutamias speciosus sequoiensis Howell

Eutamias speciosus callipeplus, Merriam, 1897:202 (part); Grinnell, 1913:351 (part).

Tamias frater, Elliot, 1907:150 (part).

Eutamias speciosus sequoiensis Howell, 1922:180 (original description); Grinnell, 1923:322; Miller, 1924:205; Anthony, 1928:228.

Eutamias quadrivittatus sequoiensis, Howell, 1929:88; Grinnell, 1933:129.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 30899/42799; female adult, skin and skull; Mineral King, 7300 feet altitude, east fork of Kaweah River, Tulare County, California; September 12, 1891; collected by V. Bailey, original no. 3259. (Howell, 1922:180.)

Geographic distribution.—Southern Sierra Nevada, on west slope, from Kings River Canyon south to Cannell Meadow and Taylor Meadow, southern Tulare County, and on east slope near headwaters of Cottonwood Creek, Inyo County (fig. 8). Intergrades with *frater* in northeastern Fresno County.

Westernmost localities of occurrence, from north to south, are Hume, Giant Forest, and Cannell Meadow. Easternmost localities are Bubbs Creek at 9600 feet, Little Cottonwood Creek, and Little Brush Meadow (at 9750 feet on west slope of Olancha Peak).

Characters and comparisons.—Color of sides in summer pelage close to Sayal Brown; much darker than in *frater* and slightly darker than in *callipeplus,* paler than in *speciosus.* Resembles *callipeplus* and *speciosus* in having inner light dorsal stripes more suffused with brown and outer light stripes broader than in *frater.* Underside of tail as in *speciosus,* but slightly paler; darker and with broader subterminal black band than in *frater* and *callipeplus.* Skull as in *speciosus* and *callipeplus;* slightly narrower, and with zygomata more appressed to skull anteriorly, than in *frater.*

Specimens examined.—A total of 181, from the following localities in California: *Fresno County:* Kings R. Canyon, 5000 ft., 4; Bubbs Cr., 9500–9600 ft., 2; Hume, 5300 ft., 19; Horse Corral Meadow, 7600 ft., 25. *Tulare County:* Twin Lakes, 2; Panther Peak, 3; Giant Forest, 2; Alta Trail, Giant Forest, 2; Sherman Cr., 2; Whitney Cr., 10,650–11,000 ft., 9; Whitney Meadow, 9800 ft., 16; Ramshaw Meadow, 8600 ft., 4; Little Brush Meadow, 9700 ft., E. slope Olancha Peak, 1; Jordan Hot Springs, 6700 ft., 3; Monache Meadow, 8000 ft., 12; Jackass Meadow, 7750 ft., 21; Siretta Meadow, 9000 ft., 11; ridge north of Manter Meadow, 8000 ft., 1; Taylor Meadow, 7000 ft., 18; Cannell Meadow, 7500 ft., 19. *Inyo County:* Little Cottonwood Cr., 9500 ft., 4; Cottonwood Lakes, 11,000 ft., 1.

Eutamias speciosus speciosus Allen

Tamias speciosus Allen, 1890:60 and 86 (original description, from MS of Merriam); Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:431; Elliot, 1901*a*:72, 1901*b*:487, 1905:89, 1907:149.

Eutamias speciosus, Merriam, 1897:202; Miller and Rehn, 1901:45; Trouessart, 1904:331; Stephens, 1906:79; Grinnell, 1908:139.

Eutamias speciosus speciosus, Miller, 1912:314; Grinnell, 1913:350; Grinnell and Swarth, 1913:325; Howell, 1922:184; Grinnell, 1923:322; Miller, 1924:205; Anthony, 1928:228.

Eutamias quadrivittatus speciosus, Howell, 1929:89; Grinnell, 1933:130.

Type.—U. S. Nat. Mus., no. 186462; male adult, skin and skull; head of Whitewater Creek, 7500 feet altitude, San Bernardino Mountains, San Bernardino County, California; June 22, 1885; collected by F. Stephens; formerly in Merriam Coll., no. 1148/1804. (Allen, 1890:86; Howell, 1929:89.)

Geographic distribution.—Isolated Boreal summits of Piute Mountains, San Bernardino Mountains, and San Jacinto Mountains (fig. 8). Also recorded by Howell (1929:90) from San Gabriel Mountains.

Characters.—Color of sides and of underside of tail darker than in other races of *Eutamias speciosus,* nearest in this respect to *sequoiensis.* Dorsal stripes as in *sequoi-*

ensis. Subterminal black area on underside of tail more extensive than in other subspecies; central reddish area on underside of tail darker and narrower, tending to fuse toward tip with the bordering black area, and frequently wedge-shaped posteriorly rather than square-ended as in other subspecies. Skull similar to that of *sequoiensis.*

Specimens examined.—A total of 162 from the following localities in California: *Kern County:* French Gulch, 6700–8300 ft., Piute Mts., 13. *San Bernardino County* (San Bernardino Mts.): Bear Lake, 6700 ft., 8; Bear Valley Dam, 7000 ft., 5; Bluff Lake, 7400–7500 ft., 59; Sugarloaf, 7500–8500 ft., 17; Mt. San Bernardino, 9000 ft., 1; Santa Ana R., 6500 ft., 1; S. Fork Santa Ana R., 7500–8500 ft., 11; Fish Cr., 7000–8000 ft., 2; Dry Lake, 9000 ft., 3; near San Gorgonio Peak, 8000 ft., 2; San Bernardino Mts., 1. *Riverside County* (San Jacinto Mts.): Round Valley, 9000 ft., 19; canyon east of Round Valley, 8000 ft., 1; S. slope Mt. San Jacinto, 10,000 ft., 1; Tahquitz Valley, 8000 ft., 18.

Eutamias speciosus callipeplus Merriam

Tamias speciosus Allen, 1890:86 (part).

Tamias callipeplus Merriam, 1893*b*:136 (original description); Allen, 1894:24; Trouessart, 1897:430; Elliot, 1901*a*:73, 1901*b*:487, 1905:89.

Eutamias speciosus callipeplus, Merriam, 1897:202; Stephens, 1906:80; Grinnell, 1913:351; Howell, 1922:184; Grinnell, 1923:322; Miller, 1924:205; Anthony, 1928:228.

Eutamias callipeplus, Miller and Rehn, 1901:40; Trouessart, 1904:332; Miller, 1912:307; Howell, 1929:91.

Eutamias quadrivittatus callipeplus, Grinnell, 1933:130.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 31299/43164; male adult, skin and skull; summit of Mount Pinos, 8800 feet altitude, Ventura County, California; October 20, 1891; collected by E. W. Nelson, original no. 1344. (Merriam, 1893*b*:136; Grinnell, 1933:130.)

Geographic distribution.—Summit and upper slopes of Mount Pinos (fig. 8).

Characters and comparisons.—Size larger than in other races of *E. speciosus.* Color of sides and of underside of tail slightly paler than in *sequoiensis,* in this character resembling *frater.* Outer light dorsal stripes broad, as in *sequoiensis* and *speciosus.* Black subterminal area on underside of tail restricted, about as in *frater.* Skull longer and narrower than in other subspecies (average zygomatic breadth equaling about 60 per cent of condylobasal length); zygomatic arches more closely appressed to skull.

Specimens examined.—A total of 37 from the following localities on Mount Pinos, California: *Kern County:* 1 mi. NE Mt. Pinos, 8000 ft., 3. *Ventura County:* Mt. Pinos, 8000–8500 ft., 18; 1½ mi. ESE Mt. Pinos, 8100 ft., 8; 3 mi. NW Frazier Borax Mine, 8100 ft., 8.

Remarks.—In *Eutamias speciosus,* which occupies a range that is about 600 miles long in north-south direction and nowhere more than 50 miles wide, the north-south variations are the most pronounced, largely by virtue of the great distances over which they act. As a result the four subspecies are arranged in tandem fashion on the long axis of the range of the species.

Intensity of pigmentation is a character of primary importance in this as well as in other chipmunk species. In the northern and central Sierra Nevada (subspecies *frater*) the sides of specimens in summer pelage are a bright reddish color, near Ochraceous-Tawny. In western Fresno County this changes to a darker shade, near Sayal Brown, characteristic of the population of the west slope of the southern Sierra Nevada (subspecies *sequoiensis*). The Piute Mountain series, separated from the latter by a gap of about 20 miles, is not represented by specimens in summer pelage, but, judging from other characters, it probably has similarly dark-colored sides. Southwestward across a gap of about 60 miles is the small population on

Mount Pinos (*callipeplus*) with paler sides, then across an equally wide gap southeastward from it, on the San Bernardino and San Jacinto ranges, is the darker-colored *speciosus*. The subterminal black area on the underside of the tail varies similarly in anteroposterior extent; it is short in *frater*, long in *sequoiensis*, short in *callipeplus*, and long in *speciosus*. Variation in the width of the outer light dorsal stripes occurs only between *frater* and *sequoiensis*; these stripes are narrow in *frater*, wide in the three southern races. Cranial features vary only slightly. The more southern populations have larger and narrower skulls; this tendency culminates in the isolated population of *callipeplus*.

There are also west-east variations that are equally pronounced, but they do not extend far enough geographically to produce conspicuously different forms. One of these occurs in the Yosemite region, where specimens from the lower, westernmost localities average larger than those from the higher localities near the crest of the Sierra Nevada. The second is in the Mount Whitney region, where the specimens from the lower altitudes on the west slope of the Sierra Nevada average darker in color than those from higher, more eastern localities. Among series from the latter localities, especially Monache Meadow and Jackass Meadow, there are some individuals in which the heads and shoulders are grayer than in others of the same or more western series. All the specimens from Cottonwood Creek, the only locality of occurrence on the east slope of the Sierra Nevada, are of this grayer type. These two instances represent detectable variations running across the principal axis of the range of the species. In the short distance over which they prevail, these variations are as pronounced as are those on which the named subspecies are based, and if they were carried out over twice the distance they now cover, the extreme representatives might be too dissimilar to include under the same name.

It is perhaps significant that in *speciosus* the tail, as measured to the end of the vertebrae, is shorter, whereas the terminal hairs of the tail are longer, than in the other races. The long terminal hairs here seem to compensate for the shorter caudal vertebral column, which is only about 65 per cent of the average head and body length, whereas in *frater* and *callipeplus*, which have shorter terminal hairs, it is about 70 per cent. On the other hand, in *sequoiensis*, which resembles *speciosus* in having long terminal hairs, the tail vertebrae are equal to about 75 per cent of the head and body length. This is an apparent contradiction to the trend in the other races. The various series were measured in part by different collectors, and the failure of the series of *sequoiensis* to correspond to the general trend may result from different technique in measuring. In the stuffed study skins *sequoiensis* does not appear to have a significantly longer tail than do the other subspecies.

Eutamias speciosus has long been thought to intergrade with the higher-zone race *inyoensis*, and, in late years, has been linked in the literature through that race with the species *E. quadrivittatus*. The structural and habitat differences proving that the race *inyoensis* represents a species distinct from *E. speciosus* are discussed in detail on pages 98, 99.

Canadian Zone forests of lodgepole pine, Jeffrey pine, and red fir growing mainly on the seaward slope of the Sierran divide. The present boundaries of the species correspond closely to those of its preferred habitat, except at the north, where the low-zone canyon of the Pit River seems to have prevented migration of these chipmunks farther northward along the Cascades. In the White Mountains and other ranges immediately east of the Sierra Nevada, the upper edge of the Upper Sonoran Zone piñon forest adjoins either areas of sagebrush and mountain mahogany or open Hudsonian Zone forest of the limber pine type; Canadian and Transition zones, as these occur on the west slope of the Sierra Nevada, are lacking or are reduced to scattered streamside fringes. This fact amply explains the absence of *Eutamias speciosus* from the Great Basin region.

The recurrence of populations on the isolated summits of high mountains in southern California indicates relative antiquity for the species. It is logical to suppose that these populations occupy the remnants of a former continuous range that extended from the Sierra Nevada through the Tehachapi region to Mount Pinos and thence southeastward at least to the San Jacinto Mountains. It is also significant that the five populations occurring south of the Kings River, though isolated from one another by gaps up to sixty miles wide, maintain features in common that set them off as a group distinct from the subspecies *frater* of the northern Sierra Nevada. By extremely conservative treatment the species might be divided into a northern race, *frater,* and a southern race to include the present *sequoiensis, speciosus,* and *callipeplus.* Thus isolation, as such, seems to have had little influence on the characters of this species. The most conspicuous changes occur in an area of intergradation, whereas relatively slight differences exist between the isolated populations.

Another Canadian Zone vertebrate, the fox sparrow, *Passerella iliaca,* occurs in the same area as *Eutamias speciosus,* and the breeding ranges of the various subspecies of the sparrow, as worked out by Swarth (1920), are remarkably similar to those of the chipmunk races in question. In each species there is a wide-ranging subspecies on both slopes of the northern and central Sierra Nevada, which is replaced in the vicinity of the Kings River Canyon by a recognizably different form ranging over the western slope only of the southern Sierra Nevada and recurring on the high mountains in southern California. In *Passerella* all the southern populations are included under one subspecies, whereas in *Eutamias* they have been separated into three weakly differentiated subspecies. But in both the sparrows and the chipmunks the primary division occurs in the vicinity of Kings River Canyon. Swarth points out (*loc. cit.*, pp. 174–175) that this canyon is at least a partial barrier to the north-south distribution of a Canadian Zone species in that it carries Transition Zone conditions far back into the mountains, then rises abruptly at its head to the Hudsonian and Arctic-Alpine zones, pinching Canadian to a narrow strip. Specimens of chipmunks from Kings River, at 5000 feet, and from Bubbs Creek, at 9500 and 9600 feet, indicate that the range of *Eutamias speciosus* is continuous around the head of the canyon.

The race *callipeplus* is geographically intermediate between *sequoiensis* and *speciosus,* yet in color and in cranial characters *callipeplus* is more distinct from them than they are from one another. The most distinctive feature of *callipeplus* is its comparatively pale coloration, and this may logically be correlated with the more open type of forest it inhabits. This small population has probably had to adapt itself to a more rapidly changing environment on Mount Pinos than have the populations of the Sierra Nevada and the San Bernardino Mountains. The gradual up-slope retreat of Boreal conditions has reduced the area available to *callipeplus* to a few square miles of forest, which is zonally scarcely above Transition and is comparable to the lowest parts of the ranges of *sequoiensis* and *speciosus* in the higher and more extensive mountain masses.

The specimens I have seen from the Piute Mountains are all in fresh winter pelage, a seasonal stage not adequately represented in the other southern populations of *Eutamias speciosus.* On the basis of cranial characters and general color pattern the Piute Mountains specimens are not referable to *callipeplus,* but might be referred equally well to either *sequoiensis* or *speciosus.* Therefore, I have relied on Howell's (1929:90) determination of other specimens in including this population under the name *speciosus.*

Eutamias townsendii Bachman

Tamias Townsendii Bachman, 1839:68.

The large chipmunks of this species inhabit the Boreal forests of the Coast and Cascade ranges and the Sierra Nevada from southern British Columbia to central California. The range of *townsendii* complements, both zonally and geographically, the ranges of *Eutamias sonomae* of northwestern California, *E. merriami* of southern California and northern Lower California, and *E. dorsalis* of the eastern Great Basin and southern Rocky Mountain regions, and in part overlaps that of *E. quadrimaculatus* of the central Sierra Nevada. All these species have been considered members of the "*Eutamias townsendii* group" (see Merriam, 1897:194–199, and Howell, 1929:106–134), principally on the basis of two characters, large size and white or whitish tail edging. The range of *E. dorsalis* lies entirely outside the geographical scope of the present paper. *E. sonomae* and *E. merriami* are closely related to one another and bear superficial resemblances in size and coloration to *E. townsendii,* but are clearly separated from this species by cranial and other characters as well as by differences in habitat and time of breeding. *E. quadrimaculatus* is more similar to *E. townsendii,* but it also is specifically distinct.

As it occurs in California, *Eutamias townsendii* exhibits a greater extent of geographic variation than does any other species of *Eutamias* in the state. It is likewise the only chipmunk species that inhabits both the humid redwood forests of the northwest coast and the relatively arid forests of the Sierra Nevada.

Geographic distribution.—In California, coastal and mountainous areas of northern part of state, including: coastal "redwood" strip from Oregon state line south to Freestone, Sonoma County; Siskiyou, Salmon, and South Fork

cross ranges; inner Coast Range south to include South Yolla Bolly Mountain and Snow Mountain; Cascade Range and Sierra Nevada south to Shaver Lake; Modoc Lava Beds area and Warner Mountains (fig. 9). Outside Cali-

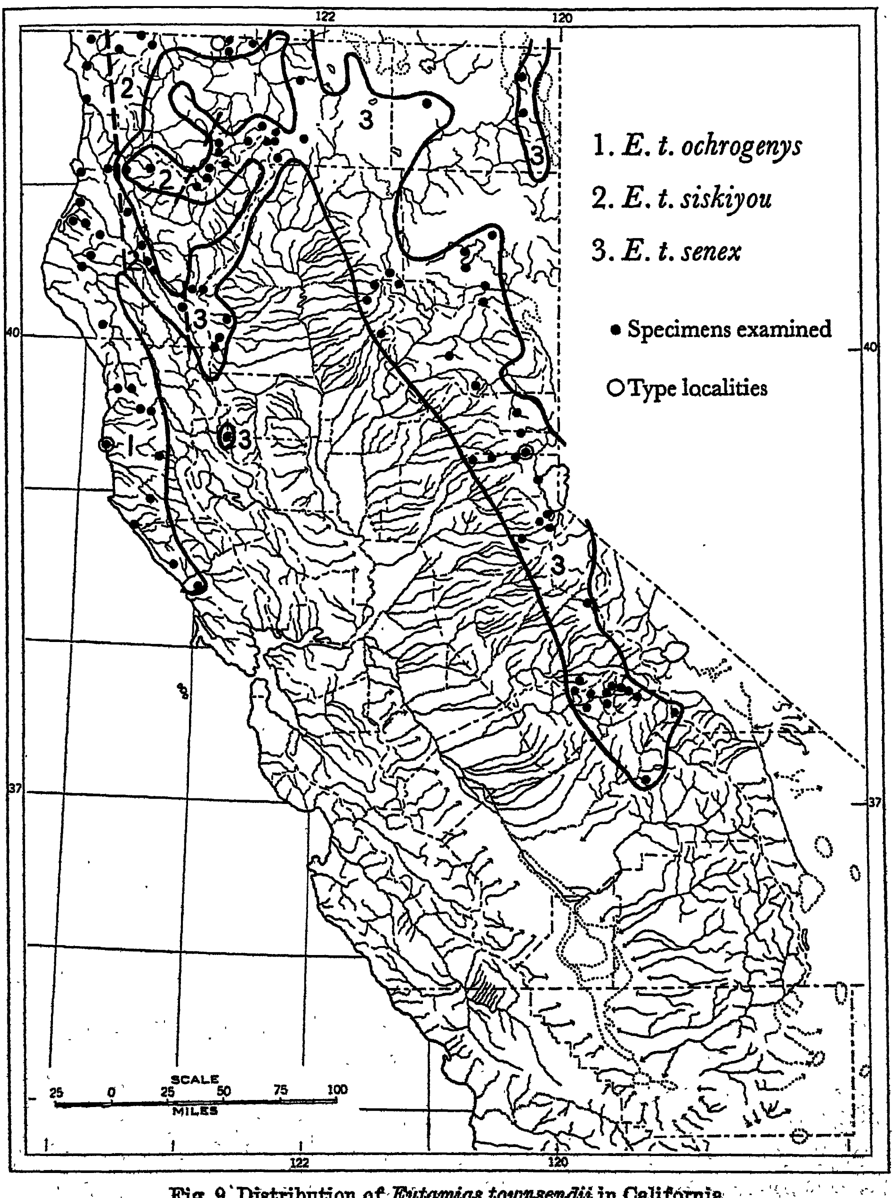


Fig. 9. Distribution of *Eutamias townsendii* in California.

fornia, coastal and Cascade regions of western Oregon and Washington, and extreme southwestern mainland of British Columbia; north to the lower Fraser River, east to Lake Chelan, Washington, and to Arnold Ice Cave (10 miles south and 8 miles east of Bend) and Lakeview, Oregon (Howell, 1929: 106–117, and additional specimens in Mus. Vert. Zoöl.).

The species inhabits chiefly the Canadian and the upper part of the Transition life-zones. The total altitudinal range in California is from near sea level (Eureka, Mendocino City, and Gualala) to 9000 feet (Cloud's Rest Trail, Mariposa County), but locally it seldom has a vertical range of more than 4000 feet. It ranges from sea level to at least 3000 feet (Coyote Peak) in the coastal "redwood" region, from 1900 (at the western end) and 3400 (at the eastern end) to at least 6000 feet in the Siskiyou Mountains, from 3200 to 7200 feet in the Salmon-Scott Range, from 3200 to 5200 feet on South Fork Mountain, from 4800 to 8300 feet on Mount Lassen, and from 4600 to 9000 feet in the Yosemite region.

Habitat.—Coniferous forests, especially where growing in fairly mature stands, or where stumps and logs of large diameter remain after forests have been cut or burned. Forages principally over log-strewn forest floors and into adjacent chaparral areas; climbs freely on trunks and lower branches of large trees, occasionally ascending 50 feet or more above ground. Associated with various coniferous trees, including Jeffrey pine, sugar pine, white fir, red fir, Douglas fir, incense cedar, and redwood, and with chaparral or understory shrubs, including snowbrush, manzanita, salal, Sadler oak, and vine maple.

Characters.—Size large; in point of body size largest in the genus; length of head and body averaging about 139 mm.; greatest length of skull averaging about 38.5 mm.; weight of adult males averaging about 85 grams. Tail length medium, averaging about 77 per cent of head and body length. Feet relatively short; length of hind foot (dry) averaging about 36.0 mm., or about 26 per cent of head and body length. Ear length medium; averaging about 13.6 mm. or about 9.8 per cent of head and body length.

Coloration varying from tawny or olivaceous with obscure stripes and tawny underparts (near coast) to grayish ochraceous with conspicuous stripes and white underparts (in Sierra Nevada). Light and dark markings in general weakly contrasted, tending to blend at borders. Ochraceous pigments relatively dominant; light facial stripes and cheeks always more or less clouded. Backs of ears fully furred, with conspicuous white posterior third in all pelages. Dark facial stripes brown nearly throughout; submalar dark stripe continuous anteriorly with ocular; concentration of ochraceous pigment on cheek suggesting incipient genal dark stripe. Dark dorsal stripes brown, central stripe nearly black. Inner pair of light dorsal stripes dull gray or brown; outer pair white, more or less clouded with gray or ochraceous. Tail relatively slender and sparsely haired, not so bushy as in *quadrimaculatus* and *sonomae*; reddish central area on underside of tail becoming darker toward base; submarginal black area on underside uniformly conspicuous laterally for entire length of tail, about 10 mm. in anteroposterior width terminally; edging white.

Skull massive, broad, and flattened. Brain case relatively small, slightly flattened on top, sloping at sides. Zygomatic arches flaring widely from skull; upper part of zygomatic process of squamosal nearly horizontal; outermost borders of arches straight and nearly parallel. Rostrum broad anteriorly; nasals approximated throughout their length, tips of nasals not separated by

terminal notch. Incisive foramina averaging about 3.0 mm. long. Palate terminating posteriorly in slender median spine (frequently broken in cleaning and subsequent handling of skull). Upper incisors moderately recurved; cheek teeth large and massive.

Comparisons.—*Eutamias townsendii* may be distinguished from all other Californian chipmunks except members of the *townsendii* group by its large size.

From *E. quadrimaculatus, E. townsendii* differs in slightly greater size, shorter ears, less bushy tail, duller coloration with white areas more clouded and tail edging less conspicuous, brown rather than black dark facial stripes (the submalar not ending posteriorly in a diffuse blackish area), larger skull, shorter nasals, heavier rostrum, longer incisive foramina, and larger teeth.

E. townsendii differs from *E. sonomae* and *E. merriami* as follows: body heavier; legs, tail, and ears shorter; tail narrower and less bushy; cheeks

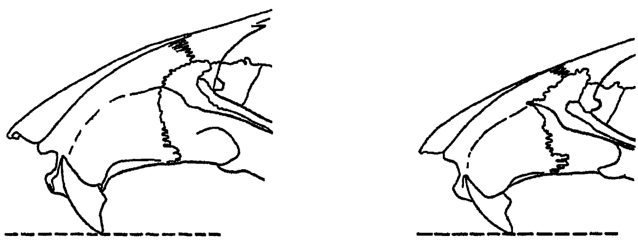


Fig. 10. Drawings, in lateral view, of anterior parts of skulls of *Eutamias townsendii* and *Eutamias sonomae*, showing less recurved position and less sharply notched occlusal surfaces of upper incisors of *townsendii*. Twice natural size.

brown or brownish rather than gray in winter pelage; backs of ears well furred and bicolored rather than sparsely furred and unicolored in summer pelage; central reddish area on underside of tail becoming darker rather than paler anteriorly; skull broader; brain case relatively smaller and less inflated; zygomatic arches less closely appressed to skull; anterior tips of nasals not separated from one another by notch; incisive foramina longer; posterior edge of palate thin and terminating in long, slender spine, rather than thickened and with short spine; upper incisors less recurved, angle of notch across occlusal surfaces less acute (fig. 10); cheek teeth larger.

Measurements.—See table 4, pages 116–117.

Subspecies.—The three Californian subspecies of *Eutamias townsendii* are based on the progressive variations toward paler color, smaller size, and broader skull in specimens from localities farther inland as compared with specimens taken near the coast. The area of intergradation between *ochrogenys* and *siskiyou* at the inner border of the redwood region is narrow; consequently these two races are easily distinguished from one another, and the line separating them geographically can be drawn with a fair degree of accuracy. Between *siskiyou* and the easternmost race, *senex*, no sharp line can be drawn, either geographically or in point of characters; intergradation takes place over a broad area, and the distinguishing characters are relatively weak.

The three races have characters and general ranges as indicated in the following key:

1. Colors darker (olivaceous in winter pelage; deep ochraceous in summer pelage); cheeks and underparts ochraceous; size larger, greatest length of skull averaging about 39.5 mm. Coastal redwood area . . . . *ochrogenys* (p. 114)

1′. Colors paler; cheeks and underparts white, never more than lightly washed with ochraceous; size smaller, greatest length of skull averaging about 38.5 mm.

2. Colors darker, more brownish. Siskiyou, South Fork, Marble, and western Salmon mountains . . . . *siskiyou* (p. 114)

2′. Colors paler, more grayish. Yolla Bolly, eastern Salmon, Cascade, and Warner mountains and northern and central Sierra Nevada . . . . . *senex* (p. 115)

Eutamias townsendii ochrogenys Merriam

Tamias townsendii, Baird, 1857:300 (part).
Tamias asiaticus var. *townsendi*, Allen, 1877:704 (part).
Tamias asiaticus Townsendi, Townsend, 1887:bottom of p. 171.
Tamias townsendii hindsii, Allen, 1890:75 (part).
Eutamias townsendi ochrogenys Merriam, 1897:195 and 206 (original description); Trouessart, 1899:1312, 1904:331; Stephens, 1906:85; Grinnell, 1913:352, 1915: 321, 1917:123.
Tamias townsendi ochrogenys, Elliot, 1901*a*:71, 1901*b*:487, 1905:87, 1907:145.
Eutamias townsendii ochrogenys, Miller and Rehn, 1901:45; Miller, 1912:314; Howell, 1922:184; Grinnell, 1923:322; Miller, 1924:206; Anthony, 1928:230; Howell, 1929:112; Grinnell, 1933:130.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 67182; male (sex of type given as female by Howell [1929:112]) adult, skin and skull; Mendocino, Mendocino County, California; July 17, 1894; collected by J. E. McLellan, original no. 1015. (Merriam, 1897:206.)

Geographic distribution.—In California, humid coastal belt of northern part of state, from Oregon boundary south to Freestone, Sonoma County, and nowhere more than twenty-five miles inland. Easternmost localities of occurrence, arranged from north to south: 9 miles east of Crescent City, Coyote Peak, Fair Oaks, 10 miles northwest of Ukiah, and Freestone (fig. 9). Elsewhere, coastal region of southwestern Oregon; said by Howell (1929:108) to intergrade with *E. t. townsendii* in vicinity of Myrtle Point, Douglas County.

Characters and comparisons.—Size larger than in *siskiyou* and *senex*; tail longer, colors darker; sides near Ochraceous Tawny in summer pelage, underside of tail near Mikado Brown and approaching Verona Brown at base; skull longer and narrower; incisive foramina shorter.

Specimens examined.—A total of 176, from localities in California as follows: *Del Norte County:* Wimer Spring, 1800 ft., 7 mi. E (town of) Smith River, 1; Bald Hill, 9 mi. E Crescent City, 4; Requa, 12 (Calif. Acad. Sci.). *Humboldt County:* Coyote Peak, 3000 ft., 7; Trinidad, 3; near Trinidad, 1; N. side Mad R., 1; Arcata, 1; Eureka, 7; Freshwater, 2; Fair Oaks, 18; Cuddeback, 5; Eel R., 150 ft., opposite Scotia, 2; 2½ mi. E Briceland, 1. *Mendocino County:* near Rockport, 1; 6½ mi. SW Laytonville, 1800 ft., 2; Sherwood, 23; 5 mi. N Willits, 1; Mendocino, 26; Lake Leonard, 10 mi. NW Ukiah, 1; Albion R., near McKay's Gulch, 1; Albion R., at Macdonald's Ranch, 1; 3 mi. N Ornbaun Spring, 1; Navarro R., west of Ukiah, 8 (Calif. Acad. Sci.); Gualala, 22. *Sonoma County:* Sonoma Co. side Gualala R. (near Gualala, Mendocino Co.), 1; 7 mi. W Cazadero, 13; Freestone, 10.

Eutamias townsendii siskiyou Howell

Eutamias senex, Merriam, 1897:196 (part); Grinnell, 1913:352 (part).
Eutamias quadrimaculatus senex, Stephens, 1906:83 (part).
Eutamias townsendii siskiyou Howell, 1922:180 (original description); Grinnell, 1923:322; Miller, 1924:206; Anthony, 1928:230; Howell, 1929:113; Grinnell, 1933:130.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 161033; female adult, skin and skull; near summit of White Mountain, 6000 feet altitude, Siskiyou Mountains, Siskiyou County, California; September 16, 1909; collected by N. Hollister, original no. 3432. (Howell, 1922:180–181.)

Geographic distribution.—In California, three discontinuous areas, including seaward slopes and higher parts of Siskiyou, Marble, and South Fork mountains of eastern Del Norte and Humboldt and western Siskiyou counties (fig. 9). Intergrading toward west with *ochrogenys* and toward east with *senex*. Westernmost records of occurrence, Patricks Creek, Horse Mountain, Blake Lookout, 12 miles east of Bridgeville (Howell, 1929:114), and South Fork Mountain; easternmost records, 4½ miles southwest of Hilt and mountains south of Greenview; southernmost record, Horse Ridge, southeast of Ruth. Outside California, Siskiyou Mountains of southwestern Oregon, intergrading eastwardly with *senex*, and recorded north to west base of Three Sisters (Howell, 1929:114).

Characters and comparisons.—In all characters noted, intermediate between *ochrogenys* and *senex*, but more similar to the latter. Colors in general dark ochraceous; dark facial and dorsal stripes more blackish than in *senex;* sides between Clay Color and Tawny Olive in winter pelage; underside of tail Ochraceous Tawny; skull shorter and relatively broader than in *ochrogenys*, its greatest length averaging about 38.5 mm.; rostrum narrower than in *senex*.

Specimens examined.—A total of 103, from localities in California as follows: *Del Norte County:* Patricks Cr., 3 (Calif. Acad. Sci.); East Fork Illinois R., 1900 ft., ¼ mi. S Oregon state line, 10; head east fork Dunn Cr., 5000 ft., 2. *Siskiyou County:* Poker Flat, 5000 ft., 12 mi. NW Happy Camp, 10; Indian Cr., 3400 ft., 12 mi. NW Happy Camp, 1; Bald Mtn., 2 (Calif. Acad. Sci.); head Doggett Cr. (between Horse Cr. and Beaver Cr.), 5800 ft., Siskiyou Mts., 14; Donomore Meadow, 5800 ft., 15 mi. W Hilt, 7; west fork Cottonwood Cr., 4000 ft., 4½ mi. SW Hilt, 2; Granite Peak, Salmon Mts., 2 (Calif. Acad. Sci.); Salmon Mts., south of Greenview, 1 (Calif. Acad. Sci.). *Humboldt County:* E. side Hoopa Valley, 2300 and 3000 ft., 2 (Biol. Surv.); near Trinity Summit, 5000 ft., 10 mi. E Hoopa, 1; Horse Mtn., 4650–5200 ft., 9; South Fork Mtn., 5000 ft., near Blake Lookout, 9. *Trinity County:* South Fork Mtn., 27 (including: The Racetrack, 5000 ft., 6; 3½ mi. N Mad R. Bridge, 7; Kohnenbergers Ranch, 3200 ft., 2; vicinity of Millers Spring, 5000 ft., 8; summit of South Fork Mts., 4600 ft., 3; and 2½ mi. NE Reilley's Ranch, 5000 ft., 1); Horse Ridge, 5500 ft., southeast of Ruth, 1.

Eutamias townsendii senex Allen

Tamias senex Allen, 1890:61 and 83 (original description); Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:431; Elliot, 1898:195, 1901*a*:72, 1901*b*:487, 1905:89, 1907:148.

Eutamias senex, Merriam, 1897:196, 1899:90; Miller and Rehn, 1901:44; Trouessart, 1904:331; Miller, 1912:314; Grinnell, 1913:352; Kellogg, 1916:373; Grinnell, 1923:322; Grinnell and Storer, 1924:183; Grinnell, Dixon, and Linsdale, 1930:488; Grinnell, 1933:131.

Eutamias quadrimaculatus senex, Stephens, 1906:83.

Eutamias townsendii senex, Howell, 1922:184; A. B. Howell, 1924:35; Miller, 1924:206; Mailliard, 1927:348; Anthony, 1928:230; Howell, 1929:114.

Type.—U. S. Nat. Mus. no. 186461; adult, skin and skull; summit of Donner Pass, 7100 feet altitude, Placer County, California; July 1, 1885; collected by L. Belding; formerly in Merriam Coll., no. 1133. (Allen, 1890:83; Howell, 1929:114.)

Geographic distribution.—In California, mountains of northeastern part of state, including western part of Salmon-Scott Range, Yolla Bolly Range, Snow Mountain, Warner Mountains, Cascade Range, and Sierra Nevada south at least to Shaver Lake, Fresno County (fig. 9). Westernmost records of occurrence in area west of Sacramento Valley are head of Grizzly Creek, 12 miles north of North Yolla Bolly Mountain, and Snow Mountain; westernmost records in Cascade–Sierra Nevada mountain system are Goosenest Mountain, Mineral, Blue Canyon, and Crane Flat; easternmost records are Fort Bidwell, 5 miles north of Fre-

TABLE 4

AVERAGE AND EXTREME MEASUREMENTS IN MILLIMETERS OF ADULTS OF *Eutamias townsendii* AND *Eutamias quadrimaculatus*

Total length	Head and body length	Tail length	Hind foot (dry)	Ear from crown (dry)	Condylo-basal length	Greatest length of skull	Zygomatic breadth	Cranial breadth	Cranial depth	Interorbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias townsendii ochrogenys from Gualala, Mendocino County														
8 males					10 males									
262 250–275	152 145–161	110 102–120	35.7 35.0–37.3	13.1 11.9–14.3	35.6 35.0–36.5	39.9 39.6–40.3	21.9 21.5–22.1	17.3 16.9–17.9	12.4 12.3–12.6	8.6 8.1–9.0	12.8 12.4–13.2	6.3 6.0–6.6	2.8 2.6–3.1	6.6 6.5–6.8
8 females					8 females									
269 262–275	153 145–163	116 105–125	36.8 36.1–37.4	13.8 12.1–15.1	36.1 34.9–37.0	40.3 39.2–41.0	21.8 21.4–22.5	17.6 16.7–18.1	12.5 12.3–12.8	8.7 8.2–9.3	12.9 12.6–13.3	6.3 5.9–6.7	2.9 2.4–3.2	6.5 6.4–6.6
Eutamias townsendii siskiyou from the Siskiyou Mountains, Siskiyou County														
12 males					11 males									
245 235–260	140 131–149	104 96–120	35.2 34.1–36.5	14.1 13.1–15.1	34.4 33.1–35.1	38.6 37.2–39.4	21.3 20.6–21.8	17.0 16.3–17.6	12.0 11.7–12.3	8.6 8.0–8.9	12.6 11.5–13.3	6.1 5.8–6.3	2.8 2.5–3.0	6.3 6.1–6.7
7 females					6 females									
252 229–257	140 131–147	104 91–118	35.2 34.7–35.7	14.1 12.5–15.2	34.6 33.5–35.1	38.7 37.3–39.4	21.3 20.7–22.0	16.9 16.3–17.3	12.0 11.7–12.2	8.4 8.2–8.7	12.6 12.1–12.8	6.0 5.7–6.2	2.7 2.5–2.8	6.3 6.1–6.5

Eutamias townsendii senex from Yosemite National Park

5 males					6 males									
244 227–252	139 134–144	105 93–110	35.5 34.6–36.1	14.5 14.1–15.1	34.2 33.5–35.0	38.1 37.2–39.2	20.9 20.2–21.5	16.6 16.3–16.8	12.0 11.9–12.2	8.2 7.8–8.5	12.7 11.7–13.6	6.2 5.9–6.4	3.0 2.8–3.2	6.2 6.1–6.3
12 females					13 females									
249 235–265	143 135–149	106 95–122	35.6 34.6–36.7	14.1 13.1–15.1	34.3 33.7–35.3	38.2 37.1–39.3	21.2 20.8–21.6	17.0 16.6–17.7	12.2 11.7–12.6	8.4 8.0–8.7	12.4 12.0–13.1	6.1 5.9–6.3	3.0 2.7–3.1	6.3 6.2–6.4

Eutamias quadrimaculatus from Yosemite National Park

16 males					11 males									
231 200–240	138 125–150	94 85–106	34.5 33.8–36.3	14.9 13.7–16.1	33.0 32.5–33.7	36.8 36.1–37.5	20.7 20.3–21.1	16.7 16.3–17.1	11.5 11.1–12.1	8.9 8.3–9.6	12.5 11.9–13.2	5.6 5.5–5.8	2.4 2.2–2.7	5.7 5.4–6.1
14 females					12 females									
237 229–245	141 125–150	96 88–118	35.1 33.8–36.3	15.3 12.6–17.5	33.3 32.5–33.9	37.2 36.5–38.1	20.7 20.2–21.4	16.6 16.2–17.1	11.6 11.4–11.9	8.9 8.5–9.3	12.5 11.8–13.0	5.6 5.3–5.9	2.7 2.4–3.0	5.8 5.4–6.0

donyer Peak, Markleeville, Washburn Lake, and vicinity of Mammoth; southernmost records are Snow Mountain (in the Coast Range), Shaver Ranger Station (on west slope of Sierra Nevada), and Mammoth (on east slope of Sierra Nevada). Outside California, in central and southern Oregon, including crest, eastern slope, and forested areas immediately east of Cascade Range, north to 20 miles west of Warm Springs and east to Arnold Ice Cave and Warner Mountains (Howell, 1929:107 and 117); in extreme western Nevada, small area along east shore of Lake Tahoe (specimens in Biol. Surv. Coll. from Glenbrook).

Characters and comparisons.—Smaller and paler than *ochrogenys* and *siskiyou*. Colors generally ochraceous, more or less tinged with light gray, especially in winter pelage; dark facial stripes browner, less blackish, than in *siskiyou;* light facial stripes and underparts white, faintly washed with ochraceous; sides in winter pelage near Clay Color, more ochraceous in summer pelage. Skull broad and flat; zygomatic arches flaring widely from brain case.

Specimens examined.—A total of 393, from localities in California as follows: *Siskiyou County:* head Rush Cr., 6400 ft., 3; S. Fork Salmon R., 5000 ft., 1; Wildcat Peak, 7200 ft., 3; Jackson Lake, 5900 ft., 14; Kangaroo Cr., 1; above Stewart's Springs (about 3 mi. SW Edgewood), 1 (Calif. Acad. Sci.); 3 mi. SW Weed, 1; 5 mi. SW Weed, 1; Castle Lake, 5434 ft., 35; 3 mi. N summit Goosenest Mtn., 1; Mt. Shasta, 10; Bray's Wells, 1 (Calif. Acad. Sci.). *Trinity County:* head Bear Cr., (W. slope Mt. Eddy), 6400 ft., 25; Grizzly Cr., 5600 ft., 2; N. fork Coffee Cr., 4500 ft., 9; divide 12 mi. N North Yolla Bolly Mtn., 4400 ft., 6. *Shasta County:* 3 mi. W Knob, 5 (Calif. Acad. Sci.); Burney, 1 (Calif. Acad. Sci.); Warner Cr., 8300 and 6600 ft., Mt. Lassen, 12. *Tehama County:* Mt. Tomhead, 5000 ft., 2; vicinity South Yolla Bolly Mtn., 3; 4 mi. S South Yolla Bolly Mtn., 2; 2 mi. W Black Butte, 6800 ft., on Lassen Road, 2; Mineral, 4800 ft., 1; Summit Cr., 5200 ft., 2 mi. E Mineral, 4; N. side Turner Mtn., 5000 ft., near Battle Cr. Meadows, 1. *Lake County:* E. Snow Mtn., 6900 ft., 1 (D. V. Hemphill Coll.). *Modoc County:* 20 mi. NW Canby, 4500 ft., 1; Sugar Hill, 6; head north fork Parker Cr., Warner Mts., 3; Parker Cr., 5500 ft., Warner Mts., 1. *Lassen County:* 5 mi. N Fredonyer Peak, 5700 ft., 1; Spalding's, Eagle Lake, 3; Eagle Lake at Gallatin's, 5200 ft., 3; Susanville, 1; 8 mi. S Susanville, 3. *Plumas County:* Hot Spring Valley, 32; Willow Lake, 5600 ft., 1; Quincy, 1 (Calif. Acad. Sci.); Johnsville, 5200 ft., 1; Grass Lake, 5900 ft., 2½ mi. S Johnsville, 1. *Butte County:* Jonesville, 6 (Calif. Acad. Sci.). *Sierra County:* Campbell's Hot Springs, 5000 ft., near Sierraville, 1. *Nevada County:* Independence Lake, 5; Donner Lake, 6300 ft., 1 (Ralph Ellis Coll.). *Placer County:* Blue Canyon, 5000 ft., 1; Cisco, 6000 ft., 34; Donner Pass, 7000 ft., 1; ¼ mi. S Tahoe Tavern, Lake Tahoe, 1; Hogsback Mine, 1 (Calif. Acad. Sci.). *Eldorado County:* Fallen Leaf Lake, 3; Mt. Tallac, 12 (Calif. Acad. Sci.); Glen Alpine Cr., 6600 ft., near Fallen Leaf Lake, 6; Glen Alpine Springs, 1; summit Johnsons Pass, 1; Echo, 41 (Calif. Acad. Sci.); Slipperyford (Kyburz), 1 (Calif. Acad. Sci.). *Tuolumne County:* Douglas, 1 (Calif. Acad. Sci.); Glen Aulin, 7700 ft., 2; Tuolumne R., 6400 and 7500 ft., 2; 3 mi. SE Aspen Valley, 6600 ft., 1. *Mariposa County:* Crane Flat, 6300 ft., 1; near Tamarack Flat, 6700 ft., 1; Cascade Cr., 5900 ft., Big Oak Flat Road, 1; Yosemite Cr., 6600 ft., 1; Yosemite Trail, 6300 ft., near Yosemite Falls, 1; E. fork Indian Canyon, 7300 ft., 9; Indian Cr., 7100 ft., 1; vicinity Yosemite Point, 7000–7300 ft., 7; Lady Franklin Rock, 4600 ft., Yosemite Valley, 1; near Porcupine Flat, 8100 ft., 1; Cloud's Rest Trail, 9000 ft., 1; Echo Cr. Basin, 6800 ft., 1; vicinity Merced Lake, 7200–7500 ft., 12; vicinity Chinquapin, 6200–7500 ft., 6; vicinity Mono Meadow, 7300–7500 ft., 10. *Madera County:* Washburn Lake, 7640 ft., Merced R., 2. *Fresno County:* Shaver Ranger Station, 5300 ft., 8. *Mono County:* Mammoth, 1 (D. R. Dickey Coll.).

Remarks.—Merriam (1897:195) was the first to distinguish clearly between the two "series" of races within the *townsendii* group in the northern Coast Ranges of California, as follows: "Three of the species are Boreal namely, *townsendi, ochrogenys,* and *senex.* The remaining two, *hindsi* [*sonomae* and *alleni* of the present paper] and *merriami,* belong to the Transition and Upper Sonoran belts. The group may be thus subdivided into two series, the *townsendi* or Boreal series and the *hindsi* or Sonoran series." On the basis of a series

from the vicinity of Hoopa Valley, Howell (1929:118) concluded that the races *siskiyou* and *sonomae* intergraded, thus reducing the latter to the status of a subspecies of *townsendii*. I have subsequently examined this supposedly intermediate series and found it to consist of specimens of *sonomae* collected near the floor of Hoopa Valley, probably at an elevation below 1000 feet, and of *siskiyou* collected higher in the mountains on the east side of the valley. None of the specimens is intermediate, although there is the usual superficial resemblance between the two species.

The present distribution of *Eutamias townsendii* in California indicates that the species probably is a late immigrant from the north. It seems best adapted for the environmental conditions prevailing in the coastal areas of western Washington and Oregon, where it is the only chipmunk species present. This species does not occur in the redwood forests of Marin County and the Santa Cruz Mountains, where conditions seem favorable for it. Its absence from the latter areas has allowed the resident populations of *sonomae* and *merriami* to penetrate the most humid situations, with the result that they have become modified into strongly marked "saturate" subspecies.

Eutamias quadrimaculatus Gray

Tamias quadrimaculatus Gray, 1867:435 (original description); Allen, 1890:61 and 80; Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:430; Elliot, 1901*a*:71, 1901*b*:487, 1905:88, 1907:148.

Tamias quadrivitatus var. *Townsendi*, Allen, 1874:290 (part).

Tamias asiaticus var. *townsendi*, Allen, 1877:794 (part).

Tamias macrorhabdotes Merriam, 1886:25 (type from "the Sierra Nevada mountains of central California" (=Blue Canyon, Placer Co.); Allen, 1890:61 and 78; Bryant, 1891:354; Allen, 1894:24; Trouessart, 1897:430.

Eutamias quadrimaculatus, Merriam, 1897:203; Miller and Rehn, 1901:43; Trouessart, 1904:331; Stephens, 1906:82; Miller, 1912:312; Grinnell, 1913:351, 1915:324; Howell, 1922:184; Grinnell, 1923:322; Grinnell and Storer, 1924:187; Miller, 1924:207; Anthony, 1928:231; Howell, 1929:121; Grinnell, 1933:132.

Eutamias macrorhabdotes, Miller and Rehn, 1901:41; Miller, 1912:312.

Type.—British Mus. (Nat. Hist.), no. 64.7.19.8; skin with skull inside; near (east of) Michigan Bluff, Placer County, California; November 1, 1862; collected by F. Gruber, original no. 1024. (Howell, 1929:121; Grinnell, 1933:132.)

This species is endemic to the northern Sierra Nevada. In size and color of tail edging it is clearly a member of the *townsendii* group and is apparently most closely related to *Eutamias townsendii*. Its remarkably long ears are not duplicated in any other species in the genus, and in this character it differs widely from the relatively short-eared *townsendii*. The possibility of relationship between *quadrimaculatus* and *sonomae* has been suggested by Grinnell (1915), but I believe the resemblances between these two species to be superficial. Certain characters tend to link *quadrimaculatus* with *speciosus*, but, again, these characters appear to be parallel modifications of basically different stocks.

Geographic distribution.—In California, Sierra Nevada, from vicinity of Lake Almanor, Plumas County, south to vicinity of Bass Lake, Madera County (Holdenried, 1940) (fig. 11). Westernmost records, arranged from north to

south, Merrimac, Plumas (Butte?) County, and Placerville (Howell, 1929: 123) and Sequoia, Tuolumne County. Easternmost records, Grizzly Mountain, Plumas County, and near Markleeville (Howell, 1929 :123), and near junction

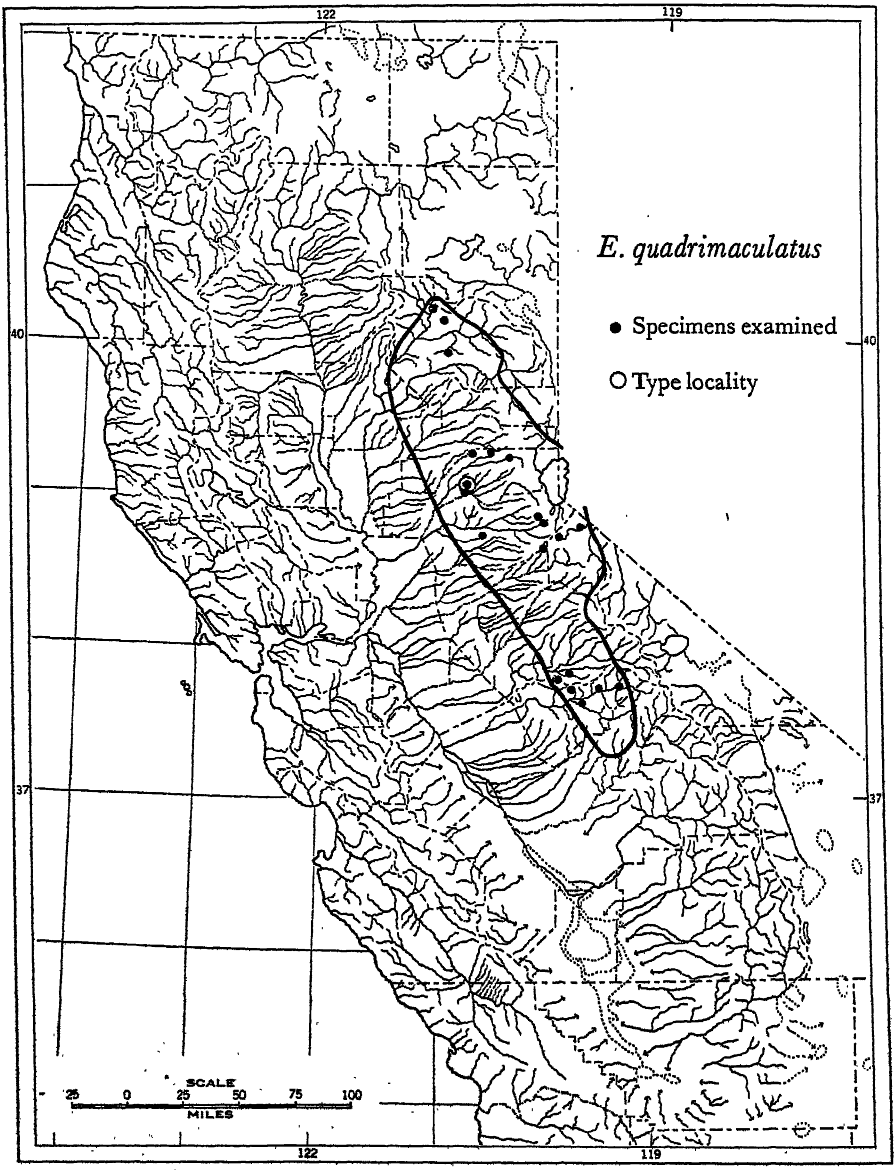


Fig. 11. Distribution of *Eutamias quadrimaculatus* in California.

of Sunrise and Cloud's Rest trails, Mariposa County. Outside California, only on eastern shore of Lake Tahoe, in Nevada.

Altitudinally, the species ranges from 3600 feet (Michigan Bluff) to 7300 feet (east fork Indian Canyon, Mariposa County). It is found chiefly in the upper half of the Transition Zone, locally in the lower part of the Canadian

Habitat.—Principally forests and brush thickets. Frequently seen running over logs and rock outcroppings. More arboreal than *townsendii,* less so than *speciosus.*

Measurements.—See table 4, pages 116–117.

Characters.—Size large (slightly smaller than in *Eutamias townsendii*); length of head and body averaging about 143 mm.; greatest length of skull averaging about 37.5 mm.; weight of adult males averaging about 79 grams. Tail moderately short, its length averaging about 64 per cent of head and body length; densely haired and compact appearing. Ears long, slender, and pointed; length (from crown on dry skin) averaging more than 10 per cent of head and body length.

Colors bright reddish, especially in summer pelage; pattern conspicuous. Light and dark facial stripes strongly contrasting; submalar stripe black at its posterior termination below ear; cheeks and light facial stripes light gray, almost white, with no admixture of ochraceous. Postauricular patches large and conspicuous. Light and dark areas on backs of ears strongly contrasting. Dark dorsal stripes variable, usually reddish; light dorsal stripes frequently suffused with ochraceous. Edging of tail white; central area on underside of tail bright reddish-orange, becoming whitish at base.

Skull small and lightly built for a member of the *townsendii* group. Zygomatic arches flaring widely from skull. Rostrum narrow and shallow. Nasals long. Brain case short and broad. Teeth relatively small; rows of cheek teeth widely spaced.

Comparisons.—*Eutamias quadrimaculatus* is larger than any of the other species except *townsendii, sonomae,* and *merriami.* It may be further distinguished from the smaller species by its white rather than buffy tail edging.

Compared with *E. townsendii, quadrimaculatus* is smaller, has longer ears, is more brightly colored, generally more reddish and less grayish, has less grayish dulling of white areas, and has a bushier tail with a more conspicuous white tail edging. The skull of *quadrimaculatus* is smaller and less massive, the nasals are longer; the rostrum is narrower and shallower; the posterior part of the zygomatic arch lies almost parallel to the longitudinal axis of the skull, rather than slanting inward anteriorly; the incisive foramina are shorter, and the molariform teeth are smaller.

Compared with *Eutamias sonomae* and *E. merriami, quadrimaculatus* is slightly smaller, and has longer ears and a shorter tail; in *quadrimaculatus* the postauricular patches and outer light dorsal stripes are more conspicuous; the backs of the ears in summer pelage are more heavily furred and more distinctly bicolored; the whitish facial and dorsal areas are less dulled by gray; the skull is smaller and relatively broader, except in the rostrum, which is narrower; the nasals are longer, the brain case shorter; there is no notch between the tips of the nasals; the spine at the posterior edge of the palate is longer and sharper (although frequently broken off in handling of the skulls).

Specimens examined.—A total of 118, from localities in California as follows: *Plumas County:* 8 mi. NW Greenville, 1 (Biol. Surv.); 5 mi. NW Greenville, 1 (Biol. Surv.); Greenville, 1 (Biol. Surv.); Quincy, 3 (Biol. Surv.); mountains near Quincy, 6 (Biol. Surv.). *Placer County:* Cisco, 6000 ft., 8; 2–2½ mi. S Soda Springs, 7000 ft., 2; Blue Canyon,

4500–5200 ft., 31; 1 mi. S Blue Canyon, 4500 ft., 1; 4 mi. N Michigan Bluff, 4200 ft., 2; 3 mi. N Michigan Bluff, 4100 ft., 1; Michigan Bluff, 3600 ft., 1. *Eldorado County:* Pyramid Peak, 1 (Calif. Acad. Sci.); Phillips Station, 1; Echo, 4 (Calif. Acad. Sci.); Fyffe, 3 (2 in Calif. Acad. Sci.). *Amador County:* Silver Lake, 2. *Alpine County:* W. fork Carson R., 5500–5700 ft., near Woodfords, 4; Hope Valley, 2. *Tuolumne County:* Aspen Valley, 6400 ft., 6; ¼ mi. S Sequoia (Crocker's Resort), 5000 ft., 1; ¼ mi. NW Hodgdon Ranch, 4900 ft., 1. *Mariposa County:* Merced Grove Big Trees, 5200–5500 ft., 16; near Gentry's, 5800–6300 ft., Big Oak Flat Road, 6; E. fork Indian Canyon, 7300 ft., 1; near junction Sunrise Trail and Cloud's Rest Trail, 7000 ft., 1; vicinity of Chinquapin, 6200–6600 ft., 11.

Remarks.—Eutamias quadrimaculatus resembles *E. townsendii senex* in aggregate of characters more closely than it does any other race in California, but it has unique morphological characters of specific value separating it from that race; there is no evidence of intergradation, though the ranges of the two overlap at many places. The large size and white-edged tail identify it as a member of the *townsendii* group, but the long ears, narrow and shallow rostrum, long nasals, and relatively great zygomatic width distinguish it from all other Californian members of the group.

Its relatively smaller size, brighter coloration, and greater zygomatic width are all characters in which *quadrimaculatus* seems to carry to an extreme the trends apparent from west to east through the subspecies *ochrogenys, siskiyou,* and *senex* of the species *Eutamias townsendii,* but its slender rostrum and smoothly rounded rather than angular appearing skull run counter to these trends.

Ecologically, *quadrimaculatus* bears something of the same relationship to *senex* in the Sierra Nevada that *sonomae* does to the subspecies of *townsendii* in the north coast region, occupying a lower zonal position and tending more toward arboreal habits. Grinnell (1915:324) and Howell (1929:122) have remarked that there is a similarity between *quadrimaculatus* and *sonomae,* but I can find no characters indicating close relationship between the two species other than tendencies toward long legs and bright coloration, and these characters are obviously correlated with the somewhat similar habits and habitats of the two. In length of tail, relative width of skull, and other cranial features, the two are quite distinct. Their ranges, also, are separated by a broad gap in the Mount Lassen region. The species *quadrimaculatus,* although occupying a lower zonal position than *E. t. senex* where the two occur together, is nevertheless a Boreal race, restricted to the upper half of the Transition Zone, whereas *sonomae* is definitely Sonoran, not being found above the lower half of the Transition Zone.

Further study of the ecological relationships of the members of the *townsendii* group would undoubtedly give us a more detailed understanding of the phylogenetic affinities of *quadrimaculatus.* In the light of present knowledge it can only be regarded as a distinct species, closest to and apparently derived from *Eutamias townsendii senex.*

In the recent revisions and lists of the *townsendii* group the sequence of races has been: *ochrogenys, siskiyou, senex, sonomae, alleni, quadrimaculatus, merriami, pricei,* etc. Throughout this paper I have placed *quadrimaculatus* between *senex* and *sonomae,* which to me seems a more natural position for it than between *alleni* and *merriami.* The species *quadrimaculatus,* as indicated

above, is closer phylogenetically to *senex* than to any other race. Both *sonomae* and *alleni* are obviously northern races of a natural group of Upper Sonoran chipmunks represented in central and southern California by the subspecies of *Eutamias merriami.* This proposed shift in the position of *quadrimaculatus* thus places it nearer the *townsendii* series, to which it is most closely related, and also removes it from a wedgelike position between two members of the *merriami* series.

Eutamias sonomae Grinnell

Eutamias sonomae Grinnell, 1915:321.

This species and *Eutamias merriami* together form a distinct subgroup within the *townsendii* group. In many characters they are closely related to one another and differ from all other forms of *Eutamias.* Their inclusion in the *townsendii* group is based principally on their large size and white tail edging. Intergradation between *sonomae* and *siskiyou,* a subspecies of *townsendii,* has been thought to occur, but in reality *sonomae* and the various subspecies of *townsendii* with which it comes in contact behave towards one another as full species. Chipmunks now placed in this species have had an involved taxonomic history. As indicated in another section of this paper, the name *Tamias hindsii* was probably applied originally to a member of this species, but for the present this name cannot be satisfactorily applied to any form. Then, there has been confusion of *sonomae* with the species *townsendii.* The division into systematic units (species and subspecies) here employed for the *townsendii* group in California is, it is thought, as accurate as the present material will allow, but the final application of names must await positive identification of the type specimen of *T. hindsii.*

Geographic distribution.—Coast ranges of northwestern California, from Klamath River south to San Francisco Bay and from coast (in part) east to western edge of Sacramento Valley and, at north, to edge of Great Basin region (fig. 12). It has never been collected outside California.

The known altitudinal range is from near sea level (Inverness) to 6000 feet (Mount Sanhedrin). The species is restricted to the upper part of the Upper Sonoran and the lower part of the Transition life-zones, except in Marin County, where in places it inhabits areas that are probably above the middle of the Transition Life-zone.

Habitat.—Shrubs, including extensive chaparral fields, small brushy clearings in forests, and streamside thickets. Most of the foraging is done by climbing through the smaller branches of bushes, but individuals regularly seek elevated positions, such as stumps, lower limbs of pine and oak trees, and rock outcroppings, where they rest, watch intruders, and eat food gathered elsewhere. Found in association with black oak, yellow pine, digger pine, Douglas fir, white fir, redwood, incense cedar, madrone, manzanita, *Ceanothus velutinus,* and service berry.

Characters.—Size large, exceeding *townsendii* in total length, but smaller in body size; length of head and body averaging about 137 mm.; greatest length of skull averaging about 38.2 mm.; weights of adult males averaging about 70 grams. Tail long and bushy, its length averaging about 80 per cent

of head and body length. Feet relatively long and slender. Ears fairly long and pointed, averaging (from crown on dry skin) about 13 mm., or 9.5 per cent of head and body length; in summer pelage, ears nearly bare on convex surfaces.

Colors generally rich reddish, more or less dulled by gray. Shoulders and

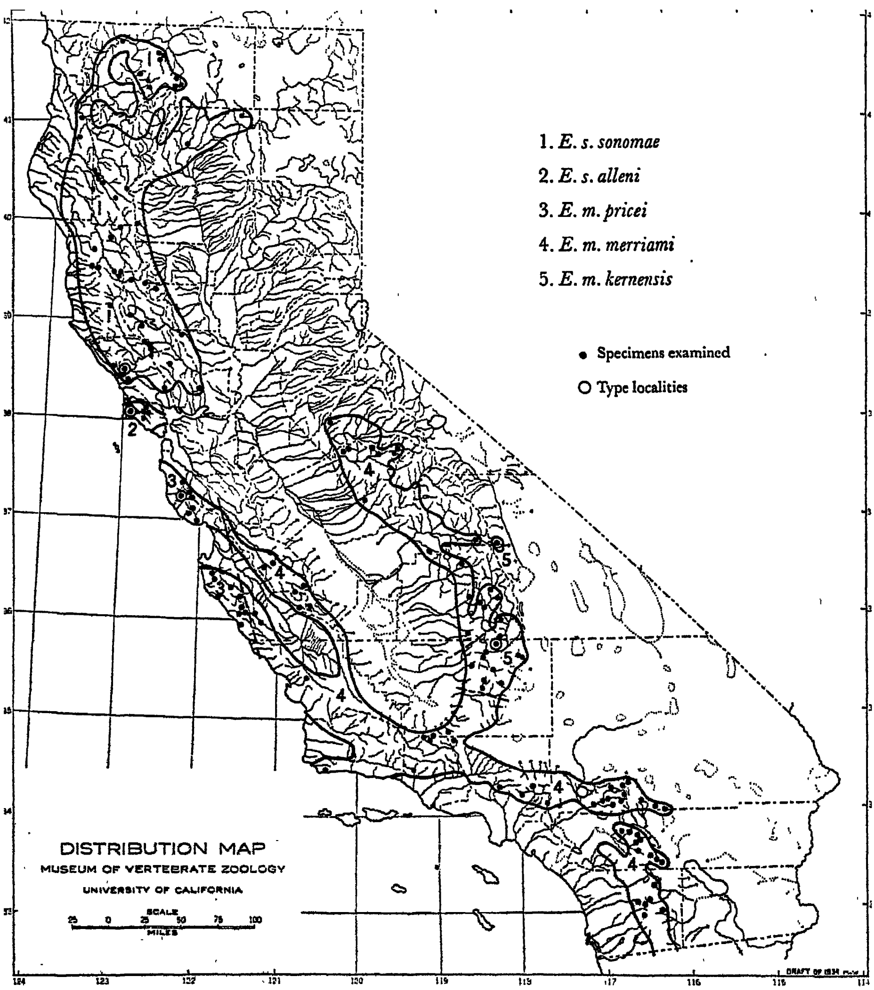


Fig. 12. Distribution of *Eutamias sonomae* and *Eutamias merriami* in California.

back with characteristic rufescent tinge not present in any other species. Cheeks and light facial stripes gray, rarely washed with ochraceous. Dark facial stripes mostly reddish, with faint black areas centrally. Sides near Sayal Brown in winter pelage, between Zinc Orange and Tawny in summer pelage. Dorsal stripes all about equally wide and not sharply contrasting; dark stripes, except outermost ones, black over midback, usually becoming deep reddish both anteriorly and posteriorly; light stripes more or less suffused with ochraceous anteriorly, approaching gray or white posteriorly. Postauric-

ular patches large but dull. Underside of tail between Tawny and Cinnamon Rufous, becoming paler, more buffy, toward base.

Skull long and narrow; zygomatic breadth averaging about 54 per cent of greatest length. Rostrum deep. Nasals separated at tips by small median notch. Brain case long and inflated. Incisive foramina short. Upper incisors strongly recurved, with sharp-angled notch in occlusal surfaces as seen in profile. Molariform teeth relatively small.

Comparisons.—In its geographic range, *Eutamias sonomae* meets only two other species, *townsendii* and *amoenus*. From *amoenus* and all other species not in the *townsendii* group it may be distinguished by its greater size, white-edged tail, and deep reddish coloration. Characters separating *sonomae* from *quadrimaculatus* and *townsendii* are given in the accounts of those species.

Eutamias sonomae is similar to *E. merriami* except in having more reddish and usually darker coloration, with less admixture of gray, and a more rounded appearing, less angular skull.

Measurements.—See table 5, pages 128–129.

Subspecies.—Two subspecies are recognized, one of which ranges widely; the other is greatly restricted. They may be distinguished as follows:

1. Size larger; colors paler; cheeks gray in winter pelage. Inner northern coast ranges generally, except in Marin County . . . . *sonomae* (p. 125)
   2. Size smaller, colors darker; cheeks brown in winter pelage. Marin County *alleni* (p. 126)

Eutamias sonomae sonomae Grinnell

Tamias townsendii, Baird, 1857:300 (part).
Tamias asiaticus var. *townsendi*, Allen, 1877:794 (part).
Tamias asiaticus quadrivittatus, Townsend, 1887:171 (part).
Tamias townsendii hindsii, Allen, 1890:75 (part); Elliot, 1898:195 (part).
Eutamias hindsi, Merriam, 1897:196 (part); Stephens, 1906:83 (part); Grinnell, 1913:352 (part).
Tamias townsendi hindsi, Elliot, 1907:144 (part).
Eutamias sonomae Grinnell, 1915:321 (original description), 1923:322, 1933:131.
Eutamias senex, Kellogg, 1916:373 (part); Mailliard, 1921:88 (part); Grinnell, 1933:131 (part).
Eutamias townsendii sonomae, Howell, 1922:184; Miller, 1924:207; Anthony, 1928:230; Howell, 1929:117, 1938:48.
Eutamias townsendii senex, Howell, 1929:114 (part).

Type.—Mus. Vert. Zoöl. no. 20825; female adult, skin and skull; one mile west of Guerneville, Sonoma County, California; July 12, 1913; collected by J. and H. W. Grinnell, original no. 2250.

Geographic distribution.—Inner coastal region of northern California, from Klamath River south to Sonoma, Napa, and Solano counties (fig. 12). Range known to extend north to Seiad Valley, vicinity of Yreka, and 1½ miles southwest of Edgewood; east to one mile south of Weed, Dana, east side of South Yolla Bolly Mountain, Fouts Springs, Rumsey, and 3 miles west of Vacaville; south to last-named locality, Eldridge, and Freestone; west to 7 miles west of Cazadero, Christine (Howell, 1929:118), Briceland (Howell, *loc. cit.*), and Horse Mountain.

Characters and comparisons.—Compared with *alleni*: size greater; tail longer and bushier; colors paler; cheeks gray rather than brown in winter pelage; light dorsal stripes usually less heavily suffused with ochraceous.

Specimens examined.—A total of 250, from localities in California as follows: *Siskiyou County*: Seiad Valley, 1400 ft., 2; Mount Vernon Mine, 4400 ft., near (5 mi. W) Yreka, 2

(Calif. Acad. Sci.); Forest House, 3000 ft., 3 mi. S Yreka, 1; Forest House Mtn., 8 mi. W Yreka, 8 (Calif. Acad. Sci.); Salmon Mts., southwest of Greenview, 3 (Calif. Acad. Sci.); Scott R., 6 mi. NW Callahan, 10; Parks Cr., 2900 ft., 1½ mi. SW Edgewood, 1; Stewart's Springs (about 3 mi. SW Edgewood), 1 (Calif. Acad. Sci.); 1 mi. S Weed, 3600 ft., 9. *Humboldt County:* Horse Mtn., 4700–5500 ft., 4; Hoopa Valley, 6 (Biol. Surv.). *Trinity County:* The Racetrack, 5000 ft., South Fork Mtn., 3; 3½ mi. N Mad R. Bridge, South Fork Mtn., 1; 2½ mi. NE Reilley's Ranch, 4200 ft., South Fork Mtn., 1; 10 mi. NW Forest Glen, 1 (Calif. Acad. Sci.); Mad R., 2600 ft., 1 mi. S Olsons Cr., 1; summit South Fork Mtn., 3 mi. NW Forest Glen, 2 (Calif. Acad. Sci.); 5 mi. S Kunz, 1; Mad R. ford, 2700 ft., above Ruth, 14; Horse Ridge, 5500 ft., southeast of Ruth, 7; 12 mi. N North Yolla Bolly Mtn., 1. *Shasta County:* Divide 12 mi. N North Yolla Bolly Mtn., 4000 ft., 2; 3 mi. W Knob, 2 (Calif. Acad. Sci.); Baird, 1 (Biol. Surv.); Dana, 11 (Biol. Surv.). *Tehama County:* E. side South Yolla Bolly Mtn., 2. *Mendocino County:* Line Gulch, 1 mi. E Castle Peak, 5500 ft., 1; Mt. Anthony, east of Covelo, 1 (J. C. von Bloeker Coll.); 3 mi. S Covelo, 1500 ft., 11; Laytonville, 28 (Calif. Acad. Sci.); Sherwood, 5 (4 in Calif. Acad. Sci.; 1 in J. C. von Bloeker Coll.); 6 mi. N Willits, 2; Hearst, 2 (Calif. Acad. Sci.); 3 mi. W summit Mt. Sanhedrin, 4500 ft., 24; Mt. Sanhedrin, 1 (Calif. Acad. Sci.); summit Mt. Sanhedrin, 6000 ft., 1; Lierly's Ranch, 2340 ft., 4 mi. S Mt. Sanhedrin, 4 (1 in Calif. Acad. Sci.); Ukiah, 1 (Calif. Acad. Sci.). *Lake County:* Pilsbury Lake, 1; Lakeport, 1 (Calif. Acad. Sci.); Kelseyville, 1; 8 mi. SW Clear Lake, 1; Castle Springs, 12 (Calif. Acad. Sci.); Harbin Springs, 2 (Calif. Acad. Sci.); near Middletown, 1 (Calif. Acad. Sci.); Lake County, 5 (Calif. Acad. Sci.). *Colusa County:* Snow Mtn., 4 (Calif. Acad. Sci.); Fouts Springs, 1 (Calif. Acad. Sci.). *Sonoma County:* 7 mi. W Cazadero, 17; 1 mi. W Guerneville, 5; Guerneville, 1; Monte Rio, 1 (Calif. Acad. Sci.); Freestone, 300 ft., 3; Eldridge, 2 (Calif. Acad. Sci.). *Napa County:* Mt. St. Helena, 2 (Calif. Acad. Sci.); Mount Mill Hotel, 1 (Calif. Acad. Sci.); Howell Mtn., 3 (2 in Pacific Union College Coll.; 1 in D. V. Hemphill Coll.). *Yolo County:* Rumsey, 500 ft., 3. *Solano County:* 3 mi. W Vacaville, 700 ft., 5.

Eutamias sonomae alleni Howell

Tamias asiaticus hindsii, Allen, 1889:178 (probably not *Tamias Hindei* Gray, 1842: 264 and *Tamias Hindsii* Gray, 1843:145).

Tamias townsendii hindsii, Allen, 1890:75; Bryant, 1891:354; Allen, 1894:24, 1895: 335; Trouessart, 1897:430; Elliot, 1898:195.

Eutamias hindsi, Merriam, 1897:196; Miller and Rehn, 1901:41; Stephens, 1906:83; Miller, 1912:309; Grinnell, 1913:352, 1915:321.

Tamias townsendi hindsii, Elliot, 1901*a*:70.

Tamias townsendi hindsi, Elliot, 1901*b*:487, 1905:86, 1907:144.

Eutamias townsendi hindsi, Trouessart, 1904:331.

Eutamias townsendii alleni Howell, 1922:181 (renaming of *Tamias asiaticus hindsii* Allen); Miller, 1924:207; Anthony, 1928:231.

Eutamias alleni, Grinnell, 1923:322; Howell, 1929:119; Grinnell, 1933:131.

Type.—U. S. Nat. Mus. (Biol. Surv. Coll.), no. 135177; male adult, skin and skull; Inverness, Marin County, California; November 16, 1904; collected by N. Hollister; original no. 1378. (Howell, 1922:181.)

Geographic distribution.—Restricted to Marin County, California, where known to range from near Muir Woods north to Nicasio and northwest, on Point Reyes peninsula, to 5 miles west of Inverness (fig. 12).

Characters and comparisons.—Similar to *E. s. sonomae*, but smaller, shorter tailed, and darker colored, with more reddish suffusion throughout, especially noticeable on light dorsal stripes, cheeks, and underparts.

Specimens examined.—A total of 31, all from localities in Marin Co., California, as follows: Pt. Reyes, 5 mi. W Inverness, 1; 3 mi. W Inverness, 300–500 ft., 13; Inverness, 2; Nicasio, 7 (6 in Calif. Acad. Sci.); Lagunitas, 4 (Calif. Acad. Sci.); Bolinas Ridge, 1350 ft., 2½ mi. S Lagunitas, 1; San Geronimo, 1 (Calif. Acad. Sci.); Mailliard, 2.

Remarks.—*Eutamias sonomae* is the member of the *merriami* series that occupies most of the ecologically suitable territory in the Coast Range north of San Francisco Bay. Both in morphological characters and in habitat requirements, it is definitely allied with *E. merriami* and not, as stated by Howell (1929 :118), with *E. townsendii.* It does not intergrade with any of the other species of the *townsendii* group whose ranges overlap or approach the range of *sonomae.* From *E. merriami pricei* of the Santa Cruz region, *sonomae* is separated by San Francisco and San Pablo bays and the extensive areas of grassland bordering them. From *E. quadrimaculatus* of the Sierra Nevada, to which it bears superficial resemblance, *sonomae* is separated by an area forty or more miles wide in the Mount Lassen region in which neither species occurs. An intensive study of the vertebrate fauna of a section through Mount Lassen, extending from the Sacramento Valley well into the Great Basin region, has been made by workers from the Museum of Vertebrate Zoölogy (Grinnell, Dixon, and Linsdale, 1930), and neither *sonomae* nor *quadrimaculatus* was found in the section.

Over a large area in northwestern California, the range of *sonomae* "overlaps" that of one or another of three subspecies of *Eutamias townsendii,* namely, *ochrogenys, siskiyou,* and *senex.* Much of this apparent overlapping of ranges is due to the intricate interdigitation of ranges made possible by the rugged topography and diversified floral associations of the region. Wherever, in this area, I have made firsthand observations on them, as around the southern end of Shasta Valley and in the canyon of the Klamath River, I have found the two species to be mutually exclusive in local occurrence; *townsendii* in the Boreal Zone forests of white fir and Douglas fir and in associated chaparral such as *Ceanothus cordulatus;* and *sonomae* in the Sonoran Zone areas characterized by yellow pine, Douglas fir, black oak, and *C. velutinus.* In the middle of the Transition Life-zone, such associations are frequently found immediately adjacent to one another, and there is ample opportunity for habitation of the same general area by both species of chipmunks. Field notes of collectors from the Museum of Vertebrate Zoölogy tend to corroborate these conclusions.

The zonal difference between the two species, *townsendii* and *sonomae,* is a basic one, in that only one species occurs in each of the two primary divisions, Boreal and Sonoran. The line separating these two major life-zones is too poorly defined to prohibit intermingling of populations from each zone. Such intermingling, in a broad sense, does occur between the populations of *townsendii* and *sonomae,* but in none of the series of specimens I have examined (including the Hoopa Valley series considered by Howell intermediate between *siskiyou* and *sonomae*) have I found evidence of intergradation.

The Hoopa Valley series consists of eight specimens of *sonomae* and two of *siskiyou.* The latter, according to information on the backs of the labels, were collected on the east side of the valley at 2300 and 3000 feet altitude, respectively, whereas the specimens of *sonomae* were apparently collected on or near the valley floor, which lies at an altitude of 300 to 400 feet. In size and general dorsal coloration, the specimens of *siskiyou* are strikingly similar to those of *sonomae,* especially when September-taken (summer pelage) specimens of

TABLE 5

AVERAGE AND EXTREME MEASUREMENTS IN MILLIMETERS OF ADULTS OF *Eutamias sonomae* AND *Eutamias merriami*

Total length	Head and body length	Tail length	Hind foot (dry)	Ear from crown (dry)	Condylo-basal length	Greatest length of skull	Zygomatic breadth	Cranial breadth	Cranial depth	Interorbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias sonomae sonomae from South Fork Mountain, Humboldt and Trinity counties														
6 males					9 males									
245 240–250	137 129–142	109 105–112	35.2 34.0–36.0	13.1 12.5–13.8	34.1 33.6–34.6	38.2 37.8–38.7	20.6 20.3–21.0	16.6 16.3–17.0	12.0 11.8–12.2	8.3 8.0–8.7	12.2 11.6–12.5	6.1 5.9–6.3	2.3 2.0–2.6	4.8 5.6–6.0
17 females					16 females									
249 240–272	138 128–152	111 104–123	35.2 34.7–37.1	13.0 11.9–14.2	34.3 33.7–35.5	38.5 37.9–39.5	20.9 20.4–21.7	16.7 16.0–17.4	11.9 11.5–12.7	8.3 7.5–8.9	12.3 11.6–13.3	6.1 5.8–6.5	2.3 2.0–2.6	5.9 5.5–6.1
Eutamias sonomae alleni from Marin County														
10 males					8 males									
235 224–242	131 118–139	106 95–112	34.0 32.9–34.8	11.5 10.5–12.3	32.8 31.8–33.6	37.1 36.6–38.0	20.2 19.1–20.7	16.4 15.8–16.8	11.7 11.4–12.0	8.1 7.8–8.4	11.7 11.1–12.4	5.8 5.6–6.1	2.2 2.0–2.3	5.7 5.5–5.9
5 females					1 female									
235 228–242	131 120–141	104 93–115	34.0 33.6–35.0	11.8 11.1–13.0	32.5	36.6	19.6	16.4	11.8	8.2	11.2	5.9	2.5	5.8

Eutamias merriami pricei from San Mateo and Santa Cruz counties

10 males					7 males									
252	135	117	35.8	13.0	33.9	38.7	20.6	17.2	12.3	8.6	12.6	6.2	2.4	5.7
228–273	126–163	102–129	34.2–37.2	12.0–15.0	33.2–34.5	38.2–39.3	19.8–21.3	16.8–17.4	12.0–12.6	8.0–9.3	12.0–13.4	5.9–6.4	2.1–2.6	5.4–6.1
11 females					12 females									
256	134	122	35.9	13.1	33.9	38.3	20.4	16.9	12.3	8.6	12.7	6.1	2.5	5.8
245–277	124–151	104–140	34.3–37.5	12.1–14.5	33.0–35.3	36.9–39.4	19.5–21.0	16.4–17.4	11.8–12.9	8.1–9.3	11.9–13.5	6.0–6.3	2.3–2.8	5.4–6.0

Eutamias merriami merriami from the San Bernardino Mountains, San Bernardino County

8 males					7 males									
228	129	99	33.6	12.9	33.8	38.1	20.2	16.7	11.9	8.3	12.1	5.9	2.4	5.7
210–247	116–139	89–115	32.5–35.9	11.7–13.9	32.7–35.4	36.7–39.9	19.5–21.3	16.4–17.0	11.5–12.1	8.1–8.5	11.5–13.1	5.5–6.5	2.3–2.6	5.5–6.0
10 females					8 females									
241	135	106	33.9	12.9	33.9	38.3	20.4	16.9	11.8	8.7	12.3	5.9	2.4	5.7
225–259	119–144	92–123	32.5–35.4	12.0–14.2	33.1–34.9	37.2–39.5	20.1–20.8	16.7–17.1	11.3–12.2	8.4–9.1	11.0–13.5	5.4–6.3	2.2–2.6	5.4–6.0

Eutamias merriami kernensis from the Kern River drainage, Tulare and Kern counties

14 males					12 males									
240	131	109	34.2	13.7	33.6	37.8	20.1	16.6	12.1	8.2	12.6	6.0	2.4	5.7
229–260	123–150	102–115	33.0–36.2	13.0–15.1	31.7–35.4	36.2–40.0	19.4–20.8	16.0–17.3	11.6–12.5	7.8–8.5	11.7–13.5	5.6–6.4	2.1–2.8	5.5–5.9
22 females					16 females									
244	132	112	34.7	13.7	33.6	38.0	20.2	16.7	12.1	8.2	12.5	5.9	2.5	5.7
229–265	125–145	104–120	33.0–36.5	12.1–15.1	31.9–35.1	36.2–39.8	19.7–20.9	16.1–17.2	11.3–12.6	7.3–9.1	11.7–14.2	5.3–6.3	2.2–2.7	5.5–6.0

siskiyou are compared with June-taken (winter pelage) specimens of *sonomae.* However, a detailed examination of specimens of the two races in comparable pelage, with particular attention given to ear pattern, tail characters, and color of light facial parts, and checked by reference to size of incisive foramina and of molariform teeth, leaves but little doubt concerning the distinctness of the two species in the region. Similar mixed series, including individuals of both *townsendii* and *sonomae,* are at hand from the following localities in northwestern California: south of Greenview, southwest of Edgewood, and near Weed, Siskiyou County; Horse Mountain, Humboldt County; South Fork Mountain (several localities) and Horse Ridge, Trinity County; near Knob, Shasta County; South Yolla Bolly Mountain, Tehama County; Sherwood and near Willits, Mendocino County; Freestone and seven miles west of Cazadero, Sonoma County. The above-mentioned localities are all in the Transition Life-zone. Series from localities zonally higher consist entirely of *townsendii;* from those lower, entirely of *sonomae.*

There is considerable variation in intensity of pigmentation within the subspecies *sonomae,* correlated in general with distance from the ocean, but nowhere pronounced or constant enough to warrant subspecific designation. The darkest series are from the westernmost localities (Guerneville, near Cazadero, and Sherwood) and the palest from localities farther inland (near Vacaville, Rumsey, and near Weed). The Weed series is unusually pale, the specimens in summer pelage entirely lacking buffy color on the underparts. The series from the type locality, one mile west of Guerneville, is one of the darkest of the subspecies. Specimens from the vicinity of Mount Sanhedrin, Mendocino County, represent about a median for the race in intensity of coloration.

The subspecies *alleni* is separated from *sonomae* by a strip of grassland in southern Sonoma and northern Marin counties. At present there is no geographical connection between *alleni* and *sonomae,* but their structural similarities indicate that they belong to the same species. The range of *alleni* is separated from that of its nearest neighbor to the southward, *Eutamias merriami pricei,* by a salt-water barrier, the Golden Gate, and by adjacent areas of grassland.

Considering the environmental conditions prevailing in its habitat, *alleni* fits in well as an extreme manifestation of the general trend of variation found in *sonomae.* The individuals of the latter species from the westernmost localities, those nearest the ocean, are appreciably darker than those from farther inland, and *alleni* is best regarded as a subspecies of *Eutamias sonomae* characterized by small size and dark color.

Eutamias merriami Allen

Tamias asiaticus merriami Allen, 1889:176.

Over most of the range of *Eutamias* in the coast ranges of central and southern California, this is the only chipmunk species present. It is a brush-inhabiting form, closely related to *Eutamias sonomae,* adapted to life in the chaparral areas that are too low zonally for other species of chipmunks.

Geographic distribution.—In California, Coast Ranges, from San Francisco Bay south through Santa Cruz and Gavilan ranges, and mountains on east side of Salinas Valley, possibly continuing through Cholame district to mountains in Santa Barbara County; from vicinity of Carmel River south through Santa Lucia Mountains and mountains of San Luis Obispo and Santa Barbara counties to Mount Pinos; from vicinity of Columbia, Tuolumne County, south through Sierran foothills to Walker Basin, thence east to Walker Pass and southwest through Tehachapi district to Mount Pinos; in at least one place, Onion Valley, on east side of Sierra Nevada; from Mount Pinos southeastward through San Gabriel and San Bernardino ranges at least to Barkers Dam in Little San Bernardino Mountains; south of San Gorgonio Pass, in San Jacinto and Santa Rosa ranges and mountains of San Diego County to Mexican boundary (fig. 12). Outside California, higher mountains of northern Lower California, from California boundary south at least to La Grulla; also near San Ignacio in central Lower California.

Altitudinally the species ranges in California from near sea level (several localities in Santa Cruz, Santa Lucia, and Santa Ynez ranges) to at least 9000 feet (Onion Valley, Inyo County, and near Round Valley, San Jacinto Mountains). The life-zones inhabited are principally Upper Sonoran and the lower part of Transition; locally the species invades high Transition areas.

Habitat.—Similar in general to that of *sonomae;* principally brush, as in extensive chaparral slopes, mixed with blue oak and digger pine forests, or in thickets along streamsides and about rock outcroppings. In absence of competing species over most of range, enters wide variety of habitats. Seen in association with ceanothus and manzanita of several species, blue oak, black oak, digger pine, Coulter pine, bigcone spruce, lodgepole pine, piñon, and juniper. Forages chiefly in brush; climbs freely in trees.

Characters.—Size large, about as in *sonomae;* head and body length averaging about 130 mm.; greatest length of skull averaging about 37.5 mm.; weight of adult males averaging about 70 grams. Tail long and bushy, length averaging from 75 to 97 per cent of head and body length. Feet and ears long and slender. Ears sparsely furred on convex surfaces in summer pelage.

Colors grayish in general; saturate with ochraceous color near coast; more grayish and yellowish interiorly. Dorsal stripes all about equally wide; dark stripes mostly gray or brown; light stripes dull. Facial stripes not sharply contrasting; dark stripes seldom with black areas; light stripes grayish. Cheeks and underparts white, more or less dulled by gray; in coastal areas usually suffused with ochraceous. Tail edging usually white, often slightly buffy.

Comparisons.—The characters used to distinguish *Eutamias sonomae* from other species will serve as well for *E. merriami*, except that *merriami* lacks the rufescent dorsal tinge of *sonomae*. The large size of *merriami* will distinguish it from all the other species it encounters except *quadrimaculatus* and *townsendii*. From both the latter it differs in its much longer and bushier tail, the edging of which is duller white or slightly buffy rather than pure white, and in its narrower skull, more recurved incisors, and presence of notch between tips of nasals. From *townsendii* it differs in grayish rather than brownish cheeks, and from *quadrimaculatus* in much paler submalar stripes.

Measurements.—See table 5, pages 128–129.

Subspecies.—In its range from the redwood forests of Santa Cruz and Monterey counties to the piñon forests in Walker Pass, *Eutamias merriami* encounters conditions grading from distinctly humid to arid. These environmental changes are accompanied by pronounced differences in coat color and in size of the chipmunks. The same trend from large and dark toward small and pale individuals that is noted under similar conditions in *E. townsendii* prevails in *E. merriami.* The subspecies have characters and ranges in general as follows:

1. Size larger; tail longer; colors more deeply ochraceous. Santa Cruz and northern Santa Lucia mountains . . . . *pricei* (p. 132)

1′. Size smaller; tail shorter; colors more grayish.

  2. Colors darker. Coast ranges from range of *pricei* to Mexican boundary and western flank of southern Sierra Nevada . . . . *merriami* (p. 133)

  2′. Colors paler. Walker Basin region and vicinity of Onion Valley . *kernensis* (p. 134)

Eutamias merriami pricei Allen

Tamias pricei Allen, 1895:333 (original description), 1896:268; Trouessart, 1897:430; Elliot, 1898:195.

Eutamias merriami, Merriam, 1897:197 (part).

Eutamias merriami pricei, Trouessart, 1899:1312; Grinnell, 1913:353, 1915:321; Howell, 1922:185; Grinnell, 1923:322; Miller, 1924:207; Anthony, 1928:231; Howell, 1929:127; Grinnell, 1933:133.

Tamias townsendi pricei, Elliot, 1901*a*:70, 1901*b*:487.

Eutamias townsendi pricei, Trouessart, 1904:331.

Eutamias pricei, Miller and Rehn, 1901:43; Miller, 1912:312.

Tamias townsendi pricii, Elliot, 1905:86, 1907:145.

Eutamias hindsi pricei, Stephens, 1906:84.

Tamias townsendi hindsi, Elliot, 1907:144 (part).

Type.—Amer. Mus. Nat. Hist., no. 11288/9552; male adult, skin and skull; Portola, San Mateo County, California; April 12, 1895; collected by J. Diefenbach, original no. 511. (Allen, 1895:333–334; Howell, 1929:127.)

Geographic distribution.—Two distinct areas: mountains of San Mateo, Santa Cruz, and western Santa Clara counties, from vicinity of Menlo Park south to Santa Cruz; northern part of Santa Lucia Mountains, from Palo Colorado Canyon south at least to Partington Point and east to include Santa Lucia Peak (fig. 12). Both populations intergrade toward southeast with subspecies *merriami.* Specimens from near coast as far south as Matilija, Ventura County, though assigned to *merriami,* are intermediate between *merriami* and *pricei.*

Characters and comparisons.—Size largest in species; head and body length averaging about 130 mm., greatest length of skull averaging about 38.5 mm.; tail long, averaging about 125 mm. Colors darker than in *merriami;* distinctly more saturate with ochraceous than in *kernensis;* underparts more suffused with ochraceous than in other subspecies.

Specimens examined.—A total of 98, from the following localities in California: *San Mateo County:* Menlo Park, 1; Portola, 6 (2 in Calif. Acad. Sci.); Pescadero Cr., 3; head of Pescadero Cr. Basin, 1 (Calif. Acad. Sci.). *Santa Cruz County:* Summit Santa Cruz Mts., 5 (Calif. Acad. Sci.); ½ mi. N Brookdale, 1; head of Doyle Gulch, 5; vicinity of Bonnie Doon, 800–1900 ft., 12; Granite Cr., 4 (J. C. von Bloeker Coll.); Granite Cr., 4½ mi. N Santa Cruz, 2; Bear Cr. road, 650 ft., 2 mi. NE Boulder Cr., 2 (O. P. Silliman Coll.). *Santa Clara County:* Hidden Villa, near Stanford Univ., 1; Palo Alto, 1 (Calif. Acad. Sci.); Black Mtn., 5 (1 in Calif. Acad. Sci.); Stevens Cr., 1; Arroyo Quito, 1. *Monterey County:* "Mts., Monterey Co." (Palo Colorado Canyon), 7; Big Pines, 3700–3900 ft., 3; San Francisquito Ranch,

1 (Calif. Acad. Sci.); Partington Point Canyon, 4 (Calif. Acad. Sci.); Chews Ridge, 5000 ft., 10 (O. P. Silliman Coll.); head of Calaboose Cr., 4400 ft., 1 (O. P. Silliman Coll.); 2 mi. SW Abbott's, 1; Santa Lucia Peak, 5600 ft., 9; Upper San Antonio, 2; Avila's Ranch, 3; vicinity of Chalk Peak, 6.

Eutamias merriami merriami Allen

Tamias asiaticus intermediate between vars. *quadrivittatus* and *pallidus*, Allen, 1877: 810 (part).

Tamias asiaticus merriami Allen, 1889:176 (original description).

Tamias merriami, Allen, 1890:60 and 84; Bryant, 1891:354; Allen, 1894:24, 1895: 335; Trouessart, 1897:429; Elliot, 1901*a*:71, 1901*b*:487, 1904:137, 1905:88, 1907:146.

Eutamias merriami, Merriam, 1897:197; Miller and Rehn, 1901:41; Trouessart, 1904:331; Stephens, 1906:84; Grinnell, 1908:140.

Eutamias merriami merriami, Miller, 1912:310; Grinnell, 1913:353; Grinnell and Swarth, 1913:324; Howell, 1922:185; Grinnell, 1923:322; Miller, 1924:207; Anthony, 1928:231; Howell, 1929:123; Grinnell, 1933:132.

Eutamias merriami mariposae Grinnell and Storer, 1916:4 (new subspecies, type from El Portal, Mariposa Co.); Swarth, 1919:402; Grinnell and Storer, 1924:185.

Type.—Amer. Mus. Nat. Hist., no. 1157/728; female adult, skin and skull; San Bernardino Mountains, 4500 feet altitude, due north of San Bernardino, San Bernardino County, California; June 10, 1887 (date given by Allen; Howell [1929:123] gives it as June 13, 1887); collected by Frank Stephens, original no. 482. (Allen, 1889: 176; Howell, 1929:123.)

Geographic distribution.—In California, Coast Ranges from areas of intergradation with *pricei* in southern Santa Cruz and Santa Clara counties and Monterey County south on both sides of Salinas Valley to mountains of northern Ventura County; west flank of Sierra Nevada from vicinity of Columbia, Tuolumne County, south to Tulare County; mountains of southwestern California from Mount Pinos through San Gabriel and San Bernardino ranges at least to Barkers Dam (on San Bernardino–Riverside county line, ten miles southwest of Twentynine Palms) in the Little San Bernardino Mountains, and San Jacinto and Santa Rosa mountains and mountains of central San Diego County to the Mexican boundary (fig. 12). Outside California, known from only one locality: north end of Nachoguero Valley, in Lower California near California boundary (specimens in Mus. Vert. Zoöl.).

Characters and comparisons.—Intermediate in size, color, and length of tail between *pricei* and *kernensis*. Smaller, paler, and with relatively as well as absolutely shorter tail than in *pricei*. Larger and more saturate with ochraceous, less grayish, than in *kernensis*. Skull relatively broader than in *pricei*.

Specimens examined.—A total of 259, from localities in California as follows: *Monterey County:* Mission Cr., 2 mi. N San Antonio Mission, 1 (O. P. Silliman Coll.); Jolon, 10; San Lorenzo Cr., Peachtree Valley, 1. *San Benito County:* Near Cook P. O., 1300 ft., Bear Valley, 4; Butts Ranch, 3000 ft., 5 mi. NNE San Benito, 3; Big Oak Flat, 3300 ft., 4 mi. NE San Benito, 2; 1 mi. SE summit San Benito Mtn., 4400 ft., 7; Laguna Ranch, 4000 ft., 4 mi. S Hernandez, 3. *San Luis Obispo County:* Santa Margarita, 1000 ft., 3. *Santa Barbara County:* Bulitos Cr., 7 mi. W Gaviota, 1. *Tuolumne County:* 1/4 mi. E Columbia, 1; Merced Grove, 1. *Mariposa County:* El Portal, 2000 ft., 3; Yosemite Valley, 4000 ft., 2; vicinity of Columbia Point, 5000 ft., 3; 1 mi. W Coulterville, 1600 ft., 2; 3 mi. NE Coulterville, 3200 ft., 3; 3 mi. W Dudley, 3000 ft., 1; Dudley, 3000 ft., 5. *Madera County:* Raymond, 940 ft., 5. *Fresno County:* Waltham Cr., 1850 ft., 4 1/2 mi. SE Priest Valley, 2; Kings River Canyon, 5000 ft., 19; 1 mi. S Dunlap, 1. *Tulare County:* vicinity of Lloyds Meadow, 2 (W. B. Richardson Coll.); Jordan Hot Springs, 6700 ft., 3; Little Lake, 6000–6200 ft., 3 (2 in W. B. Richardson Coll.; 1 in U. S. Nat. Park Service Coll.); Doyles Camp, 3 (Calif. Acad. Sci.). *Kern County:* Old Fort Tejon, 3200 feet., 4; Cuddy Valley, Mt. Pinos, 5 (4 in J. C. von Bloeker Coll.). *Ventura County:* Mt. Pinos, 5500–8500 ft., 21; 1/2 mi. SE Mt. Pinos, 8500 ft., 3; 3 mi. NW Frazier Borax Mine, 8100 ft., 1; 10 mi. W Lebec, 4 (J. C. von Bloeker Coll.); Cuddy Canyon, 4400 ft., 1; Matilija, 15. *Los Angeles County:* Sandberg's, 2; Big Tujunga Canyon, 3 1/2 mi. NE Sunland, 1 (J. C. von Bloeker Coll.); Pine Flats, N. fork San Gabriel R., 3; Mt. Wilson,

5700 ft., 1; San Antonio Canyon, 2. *San Bernardino County:* Santa Ana R., 5500–6000 ft., 3; Foresee Cr., 5500 ft., San Bernardino Mts., 1; Seven Oaks, 5000–5100 ft., San Bernardino Mts., 6; Fish Cr., 6500–7000 ft., San Bernardino Mts., 7; S. fork Santa Ana R., 6200 ft., San Bernardino Mts., 1; Bear Valley Dam, 7000 ft., San Bernardino Mts., 2; Fawnskin, 6800 ft., San Bernardino Mts., 1 (J. C. von Bloeker Coll.); Sugarloaf, 7500–8000 ft., San Bernardino Mts., 6; Saragossa Springs, 7538 ft., San Bernardino Mts., 1; Doble, 7000 ft., San Bernardino Mts., 1; "San Bernardino Mts.," 1; Little Morongo Valley, 3800 ft., 1 (J. C. von Bloeker Coll.); Barkers Reservoir (Dam), 10 mi. SW Twentynine Palms, Little San Bernardino Mts., 12; Quail Spring, 4200 ft., Little San Bernardino Mts., 1. *Riverside County:* Poppet Flat, 3700–4000 ft., San Jacinto Mts., 2; vicinity of Schain's Ranch, 4900 ft., 5; vicinity of Fuller's Mill, 5900–7500 ft., San Jacinto Mts., 10; Round Valley, 9000 ft., San Jacinto Mts., 1; Hidden Lake, 9000 ft., near Round Valley, 1; Tahquitz Valley, 8000 ft., San Jacinto Mts., 2; Strawberry Valley, 6000 ft., San Jacinto Mts., 6; Hemet Lake, 4400 ft., 2; Dark Canyon, 1 (J. C. von Bloeker Coll.); Kenworthy, 4500–5000 ft., San Jacinto Mts., 9; Garnet Queen Mine, 6000 ft., Santa Rosa Mts., 1; Santa Rosa Peak, 7500 ft., 3; Toro Peak, 8000 ft., 3. *San Diego County:* Warner Pass, 1; Volcan Mtn., 1; Julian, 2; Witch Creek, 1 (Calif. Acad. Sci.); Laguna Mtn., 5; Cuyamaca Mts., 2.

Eutamias merriami kernensis Grinnell and Storer

Eutamias merriami, Merriam, 1897:197 (part).

Eutamias merriami kernensis Grinnell and Storer, 1916:5 (original description); Howell, 1922:185; Grinnell, 1923:322; Miller, 1924:207; Anthony, 1928:232; Howell, 1929:128; Grinnell, 1933:133.

Type.—Mus. Vert. Zoöl., no. 15022; male adult, skin and skull; Fay Creek, 4100 ft. altitude, 6 miles north of Weldon, Kern County, California; July 13, 1911; collected by J. Grinnell, prepared by H. A. Carr, original no. 266.

Geographic distribution.—Area in southeastern Tulare and northeastern Kern counties, including drainage of south fork of Kern River, Walker Basin, Walker Pass, Kiavah Mountain, and Piute Mountains; also restricted area in vicinity of Onion Valley, on east side of Sierra Nevada, Inyo County (fig. 12). Specimens referred to subspecies *merriami* from Little San Bernardino and Santa Rosa mountains approach *kernensis* in characters, though not geographically.

Characters and comparisons.—Size small and colors pale for a subspecies of *merriami*. Back and sides grayish in winter pelage, yellowish in summer pelage; with ochraceous areas faint and restricted. Skull smaller than in other subspecies.

Specimens examined.—A total of 91, from the following localities in California: *Tulare County:* Trout Cr., 6000 ft., Sierra Nevada, 7; forks of Big and Little Kern rivers, 4 (W. B. Richardson Coll.); Taylor Meadow, 7000 ft., Sierra Nevada, 10. *Inyo County:* Onion Valley, 8500 ft., Sierra Nevada, 4; Little Onion Valley, 7500 ft., Sierra Nevada, 2. *Kern County:* Fay Cr., 4100 ft., 6 mi. N Weldon, 18; Kern R., 2500 ft., at Isabella, 2; Kern R., 2400 ft., at Bodfish, 9; Kern R., 12 mi. below Bodfish, 2; W. slope Walker Pass, 4600 ft., 5; Kiavah Mtn., near Walker Pass, 3; Thompson Canyon, 3900–4300 ft., Walker Basin, 10; 1 mi. SE Rankin Ranch, 3500 ft., Walker Basin, 1; E. end Walker Basin, 3500 ft., 1; 2 mi. N Sorrell's Ranch, 4500 ft., Kelsoe Valley, 2; French Gulch, 6700–7300 ft., 11.

Remarks.—The broad range of *Eutamias merriami* covers an area in which chaparral is the dominant type of vegetation. It seems probable that the species is a recent immigrant into the region it now occupies. Throughout its range in California it has crossed only one major low-zone barrier, San Gorgonio Pass between the San Bernardino and San Jacinto mountains. Two isolated ranges, the Santa Ana Mountains and the Diablo Range (including Mount Diablo) have brushy slopes and canyons that appear well suited to the habitat requirements of *E. merriami*, but no chipmunks occur there (see fig. 1).

Apparently the species has never been able to cross the belts of grasslands that isolate these habitable areas.

The isolated population in the vicinity of Onion Valley, on the east side of Kearsarge Pass, has characters of the subspecies *kernensis*, but is probably an independent offshoot from the populations of the subspecies *merriami* on the west slope of the Sierra Nevada. At some time individuals must have crossed the narrow Canadian and Hudsonian zone barrier through Kearsarge Pass from the canyon of the Kings River, where Transition Zone conditions are carried far eastward into the mountains. No other specimens of *Eutamias merriami* have been taken on the east slope of the Sierra Nevada, although extensive collecting has been carried on there in several localities.

The irregular outline of the range of the species results from the peculiar distribution of its habitat. These chipmunks are restricted to the chaparral areas bounded by the low grasslands and deserts and the high Boreal forests. Along the eastern border of its range the species enters the arid piñon forests in Walker Pass and the Little San Bernardino Mountains; there it thrives under exceptionally arid conditions. In the Santa Cruz Mountains and parts of the Santa Lucia Mountains it seems equally at home in the humid redwood areas.

The variations in size from large to small and in color from dark to pale progressing interiorly from the coast parallel those already discussed for *Eutamias amoenus* and *E. townsendii*. By finer "splitting" it would be possible to recognize more than three subspecies of *E. merriami* in the state. The populations from the west slope of the Sierra Nevada were described by Grinnell and Storer (1916:4) as a distinct subspecies, *mariposae*, but I agree with Howell (1929:125) that there are no constant differences separating them from other populations that fall within the range of variation assigned to the subspecies *merriami*. This Sierran population of *merriami* is isolated from others of its subspecies by a population of *kernensis* along the Kern River.

The most extreme manifestation of "coastal" characters occurs in the subspecies *pricei* in the Santa Cruz and Santa Lucia mountains. The range of the largest and darkest individuals corresponds roughly with the distribution in that area of the redwood forests, which, in turn, according to Cooper (1917), are limited to areas of frequent summer fogs. The transition from *pricei* to *merriami* is gradual; specimens from southern Santa Cruz County are paler than those from the coastal slope in San Mateo County, and individuals are paler on the east side than on the west side of the Salinas Valley. At localities near the coast far south of the range of *pricei*, as near Gaviota and Matilija, the chipmunks are darker than those from farther inland, as on Mount Pinos.

The subspecies *kernensis* of the Walker Basin and Walker Pass areas includes the smallest and palest Californian representatives of the species. In them the characters associated with arid environmental conditions are most conspicuously developed. The isolated Onion Valley population is likewise pale in coloration and has been assigned to *kernensis*. Chipmunks from the Little San Bernardino and Santa Rosa mountains, which are both on the arid eastern periphery of the range of the species, though closer to *merriami*, approach *kernensis* in paleness of coloration.

The northern boundary of the range of *Eutamias merriami* in the Sierran foothills is not definitely known; the northernmost locality is represented by a specimen from Columbia, Tuolumne County, but there is no apparent barrier to the spread of the species farther northward. No chaparral-inhabiting chipmunk is known from the lower part of the Transition Zone of the Sierran foothills between the range of *merriami* and that of *E. sonomae* in the Pit River region. Possibly these two species were once connected by a range extending through this region. They are obviously derivatives of the same ancestral stock, and it seems more probable that the route of migration, whether from north to south or vice versa, was along the Sierran foothills, rather than across San Francisco Bay.

STATUS OF TAMIAS HINDSII GRAY

The name *Tamias hindsii* of Gray (1842 :264) has never been satisfactorily allocated. The type specimen, British Museum no. 42.10.30.10 (Howell, 1922: 181), was collected in 1837 or 1839 on the voyage of the ship *Sulphur,* probably by the captain, Sir Edward Belcher, or by the ship's surgeon and naturalist, Richard Brinsley Hinds. Neither Belcher's (1843) narrative of the voyage nor Hinds's (1844) summary in the "Zoölogy of the voyage of H.M.S. Sulphur" provide any statement or any definite clue where the specimen was collected. The *Sulphur* made two trips of exploration southward along the Pacific Coast of North America. On the first trip the ship entered San Francisco Bay on October 19, 1837, and departed on November 30. During the intervening period Captain Belcher, accompanied by Hinds and part of the crew, explored in small boats up the Sacramento River, as far as "Point Victoria," latitude 38° 46′ 47″ N. (probably near the mouth of the Feather River). According to Hinds (1844 :3), "Four weeks were thus spent in the open boats, and such collections made as circumstances permitted, and which did not reach the *Sulphur* without certain adventures and hair-breadth escapes. San Francisco and its neighborhood were in the meantime examined by those who remained with the ship." A four-day stop was subsequently made at Monterey.

On its second trip, in 1839, the *Sulphur* entered the mouth of the Columbia River on July 28. "A party ascended to Fort Vancouver and did not return without obtaining a few things of interest. About the middle of September the vessel sailed for California, visiting the Russian settlement of Bodegas for a few days, and afterwards San Francisco and Monterey." Santa Barbara, San Pedro, and San Diego were also visited briefly on this trip. (Hinds, 1844 :5.)

Gray's description appeared in 1842 under the name *"Tamias Hindei"*; the locality was given as "California." The next year, Gray (1843 :145) corrected the spelling to *"Tamias Hindsii."* It was cited thus, with an accompanying colored illustration, in the "Zoölogy of the Sulphur" (Gray, 1844 :34, pl. 12, fig. 1) and in the "Synopsis of the burrowing squirrels (Tamias)" (Gray, 1867 :435).

Under the conservative treatment of Baird (1857 :300) and the earlier work of Allen (1874 :290; 1877 :794), *hindsii,* as representing all northwestern Californian chipmunks, was listed as a synonym of *Tamias townsendii* Bach-

man. Later, as more specimens accumulated, it became obvious that some of the brightly colored chipmunks from this region were distinct from the dull-colored *townsendii.* By 1889 Allen was convinced of the validity of *hindsii* as a subspecies and placed it under *T. asiaticus* (Allen, 1889:178). A year later the same author treated *hindsii* as a subspecies of *townsendii,* and decided that the type specimen of "*Tamias hindsii* was almost unquestionably taken in the immediate vicinity of San Francisco, Cal., in the month of November. Hence Nicasio [Marin County] specimens may be fairly taken as representing the type locality, . . ." (Allen, 1890:75 and 77).

With the type locality thus indicated, the name *hindsii* was for the ensuing 32 years applied to the chipmunks of Marin County. Specimens from other parts of northwestern California were also included under this name until Allen (1895:333) described *pricei* from San Mateo County. Merriam (1897:195) separated the dark specimens from the humid coastal strip north of Marin County under the name *ochrogenys,* and Grinnell (1915:321) set off the paler populations of the inner northern coast ranges as *sonomae.*

In an attempt to establish definitely the identity of Gray's type specimen, A. H. Howell (1922:181–182) sent specimens of each of the three races from the San Francisco Bay region (*sonomae, "hindsii,"* and *pricei*) to the British Museum and requested Oldfield Thomas to compare them with the type. Thomas reported that, rather than resembling any of the specimens sent by Howell, the type of *hindsii* matched closely specimens in the British Museum collection of *townsendii* from British Columbia. With this evidence, and on the supposition that the type must have been collected in the vicinity of Fort Vancouver, on the Columbia River, rather than near San Francisco, Howell placed *hindsii* in the synonymy of *townsendii* and provided the new name *alleni* for the Marin County form.

Without personally comparing the type *hindsii* with specimens of the various forms in question, I cannot throw further light on this problem. However, the following facts are sufficient to convince me that there still remains a strong possibility that the type was really collected somewhere in the vicinity of San Francisco Bay. The specimen was originally labeled "California." Howell (1922:182) argues that this name was "loosely applied in those days to the greater part of the Pacific Coast of the United States," but there is Hinds's (1844:5) statement that, on leaving the mouth of the Columbia, the *Sulphur* "sailed for California," and although the name did not have its present restricted application there is no evidence that either Belcher (1843) or Hinds (1844) considered the Columbia River region a part of California. Then, Gray's original description and the colored plate in the "Zoölogy of the Sulphur" both agree more readily with the actual appearance of the Californian forms than with that of *townsendii* from the lower Columbia River. This applies especially to the white, rather than brown, outer light dorsal stripes, a character typical of the chipmunks (*sonomae*) of the inner coast ranges of California north of San Francisco Bay, but rare (among specimens at hand found only in young individuals) in *townsendii* from the lower Columbia. Farther inland in the Pacific Northwest *townsendii* does have these stripes whitish, approaching the condition in the race *cooperi.* The British Museum

TABLE 6

MEASUREMENTS, IN MILLIMETERS, OF SKULLS OF ONE INDIVIDUAL OF EACH RACE OF *Eutamias* IN CALIFORNIA

	Condylo-basal length	Greatest length	Zygo-matic breadth	Cranial breadth	Cranial depth	Inter-orbital breadth	Length of nasals	Depth of rostrum	Length of incisive foramina	Length of lower tooth row
Eutamias:										
alpinus (23343, ♀)	27.0	30.7	17.2	15.2	10.3	7.1	9.5	4.3	2.2	4.8
minimus scrutator (78558, ♀)	26.6	29.6	17.1	14.8	10.2	6.8	8.6	4.5	2.3	4.5
amoenus ochraceus (69119, ♂)	29.6	33.1	19.2	16.0	10.8	7.9	9.8	4.9	2.3	5.2
amoenus amoenus (68868, ♂)	28.8	32.3	18.4	15.5	11.0	7.9	9.9	4.8	1.9	4.7
amoenus monoensis (23380, ♂)	28.3	32.2	17.8	15.2	10.9	7.5	10.2	4.6	2.1	4.9
panamintinus panamintinus (27203, ♀)	31.6	35.1	19.2	15.9	11.3	7.5	11.0	5.2	2.3	5.1
panamintinus acrus (86164, ♂)	29.9	33.3	18.4	15.5	10.9	7.1	10.1	4.7	2.1	5.0
quadrivittatus inyoensis (27302, ♀)	31.9	35.3	19.0	15.4	10.9	8.1	11.2	5.5	2.2	5.5
speciosus frater (23423, ♂)	31.0	34.8	19.5	16.0	11.2	7.7	11.6	5.2	2.5	5.4
speciosus sequoiensis (14852, ♂)	31.4	35.9	18.8	15.7	11.3	8.6	11.4	5.3	2.0	5.2
speciosus speciosus (5301, ♂)	31.8	35.0	19.0	15.8	11.0	7.5	10.5	5.0	2.3	5.2
speciosus callipeplus (42109, ♂)	31.5	35.1	18.8	15.6	11.3	7.6	11.4	5.2	2.5	5.3
townsendii ochrogenys (19052, ♂)	36.0	40.1	22.2	17.5	12.5	8.7	11.7	6.2	3.2	6.4
townsendii siskiyou (69160, ♀)	34.9	38.8	21.2	16.8	11.7	8.3	12.5	6.0	2.7	6.1
townsendii senex (27953, ♀)	34.3	38.4	21.2	16.6	12.1	8.2	12.3	5.8	3.3	6.0
quadrimaculatus (22785, ♀)	33.6	37.3	20.8	16.5	11.8	9.1	12.5	5.8	2.8	5.6
sonomae sonomae (56912, ♂)	34.4	38.7	20.6	16.8	11.8	8.4	12.2	6.4	2.2	5.9
sonomae alleni (20438, ♂)	33.3	37.6	20.4	16.3	11.4	8.2	11.8	6.1	2.0	5.6
merriami pricei (83454, ♀)	34.2	38.3	20.5	17.0	12.3	8.7	12.7	6.1	2.5	5.8
merriami merriami (13815, ♂)	35.4	39.0	21.1	17.3	12.1	8.7	12.6	6.5	2.3	5.7
merriami kernensis (15031, ♀)	33.4	37.3	20.1	16.5	11.3	8.8	13.0	5.9	2.4	5.5

specimens from British Columbia found by Thomas to resemble Gray's type may have been of this pale kind. A specimen in the Museum of Vertebrate Zoölogy from Hope, British Columbia, has the outer light dorsal stripes whitish, whereas these are brownish in all except young specimens from the lower Columbia River region.

It seems certain that Allen's (1890:77) assumption that Marin County specimens were typical of *hindsii* was poorly founded. The party from the *Sulphur* probably never entered the present boundaries of that county, but the party may very well have reached the range of *sonomae* somewhere in Napa or Solano County.

ACCOUNT OF MIOCENE SPECIES

Eutamias ateles Hall

Eutamias ateles Hall, 1930:314, 316, figs. 1, 2 (original description).

Type.—Univ. Calif. Mus. Paleontology, no. 28521; 3 right upper molars; upper Miocene Barstow beds, 11 mi. NE Hinkley, San Bernardino County, California (fig. 1); collected in spring of 1923 by Annie M. Alexander and Louise Kellogg.

Referred specimens.—Univ. Calif. Mus. Paleontology, nos. 28522 (right M^1) and 35616 (left M^1). Hall (*loc. cit.*) also refers no. 28523, a right M_3, to this species; I have not seen this specimen. All the referred material was collected with the type.

Characters and comparisons.—Size small; apparently about as in *Eutamias amoenus*. Resembling *Tamias* and *Eutamias* and differing from *Citellus* in external divergence of protoloph and metaloph (terminology of dental pattern from Howell [1938: pl. 12, opposite p. 34]), the latter slanting posteriorly. Resembling American *Eutamias* (subgenus *Neotamias*) and differing from *Tamias* and Asiatic *Eutamias* in anteroposterior compression of upper molars, with anteriormost border of tooth (ridge extending medially from parastyle) close to protoloph rather than separated from it by wide basin; differing from Recent Californian *Eutamias* in more extreme manifestation of latter character. According to Hall (1930:314), *E. ateles* is further differentiated from Recent forms of the genus by the greatly enlarged posterointernal third of M_3.

Remarks.—The occurrence of chipmunks closely allied to Recent species of *Eutamias* in the upper Miocene of California indicates a long period of residence of the group in the region, and lends support to the idea that much of the evolutionary history leading to the present diversification of the group may have taken place here. It is not known whether chipmunks have inhabited the rest of their present range or other parts of the world for so long a time, because fossil remains of small rodents have been seldom collected and studied.

The fact that the only fossil locality is in one of the parts of California now least habitable by *Eutamias* is significant, in that it demonstrates the futility of trying to work out the evolutionary history of the group on the basis of the distribution of Recent species.

Transmitted by author June 20, 1941.

LITERATURE CITED

ALLEN, J. A.

1874. On geographical variation in color among North American squirrels, with a list of the species and varieties of the American Sciuridae occurring north of Mexico. Proc. Boston Soc. Nat. Hist., 16:276–294.

1877. Monographs of North American Rodentia. No. 11, Sciuridae. Rept. U. S. Geol. Surv. Terr., 11:631–939.

1889. Notes on a collection of mammals from southern Mexico, with descriptions of new species of the genera Sciurus, Tamias, and Sigmodon. Bull. Amer. Mus. Nat. Hist., 2:165–181. October 21.

1890. A review of some of the North American ground squirrels of the genus Tamias. Bull. Amer. Mus. Nat. Hist., 3:45–116. June.

1894. Recent progress in the study of North American mammals. Proc. Linn. Soc. New York, for year ending March 27, 1894; separately paged 1–29. July 20.

1895. Descriptions of new American mammals. Bull. Amer. Mus. Nat. Hist., 7:327–430. November 8.

1896. On mammals from the Santa Cruz Mountains, California. Bull. Amer. Mus. Nat. Hist., 17:263–270. December 4.

ANTHONY, H. E.

1928. Field book of North American mammals (New York: G. P. Putnam's Sons), xxv + 625 pp., 48 pls., 150 figs.

BACHMAN, J.

1839. Descriptions of several new species of American quadrupeds. Jour. Philadelphia Acad. Nat. Sci., 8(pt. 1):57–74.

BAILEY, V.

1936. The mammals and life zones of Oregon. U. S. Dept. Agr., Bur. Biol. Surv., N. Amer. Fauna, 55, 416 pp., 52 pls., 102 figs. June.

BAIRD, S. F.

1857. General report upon the zoölogy of the several Pacific railroad routes. U. S. Pacific R. R. Expl. and Surv., 8, xlviii + 757 pp., 44 pls., 35 figs.

BELCHER, E.

1843. Narrative of a voyage round the world, performed in Her Majesty's ship Sulphur, during the years 1836–1842 (London: Henry Colburn), 1, xxxviii + 387 pp., 8 pls., 11 figs., 3 folding maps.

BLOSSOM, P. M.

1937. Description of a race of chipmunk from south central Idaho. Occ. Papers Univ. Mich. Mus. Zoöl., No. 366, 3 pp. December 21.

BOLE, B. P., JR.

1938. Some altitude records for mammals in the Inyo-White Mountains of California. Jour. Mammalogy, 19:245–246. May 14.

BRYANT, W. E.

1891. A provisional list of the land mammals of California. Zoe, 1:353–360. February.

BURT, W. H.

1931. Three new chipmunks of the genus Eutamias from Nevada. Jour. Mammalogy, 12:298–301. August 24.

COOPER, J. G.

1868. (Zoölogy). *In* Cronise, The natural wealth of California, 7:434–501.

COOPER, W. S.

1917. Redwoods, rainfall, and fog. Plant World, 20:179–189.

ELLIOT, D. G.

1898. Lists of species of mammals, principally rodents, obtained by W. W. Price, Dr. S. E. Meek, G. K. Cherrie, and E. S. Thompson in the states of Iowa, Wyoming, Montana, Idaho, Nevada and California with descriptions of new species. Field Columbian Mus., Zoöl. Series, 1:191–222. March.

1901*a*. A synopsis of the mammals of North America and the adjacent seas. Field Columbian Mus., Zoöl. Series, 2, xv + 471 pp., 49 pls., 94 figs.

1901*b*. A list of the land and sea mammals of North America north of Mexico. Supplement to the synopsis. Field Columbian Mus., Zoöl. Series, 2:473–522, 7 pls.

1904. The land and sea mammals of Middle America and the West Indies. Pt. 1. Field Columbian Mus., Zoöl. Series, 4, xxii + 439 + xlix pp., 58 figs.

1905. A check list of the mammals of the North American continent, the West Indies, and the neighboring seas. Field Columbian Mus., Zoöl. Series, 6, iv + 761 pp., 1 pl.

1907. A catalogue of the collection of mammals in the Field Columbian Museum. Field Columbian Mus., Zoöl. Series, 8, viii + 694 pp.

GRAY, J. E.

1842. Descriptions of some new genera and fifty unrecorded species of *Mammalia*. Ann. and Mag. Nat. Hist., 10:255–267.

1843. List of the specimens of Mammalia in the collection of the British Museum. Published by the British Museum, pp. xxviii + 216.

1844. Mammalia. *In* The zoölogy of the voyage of H. M. S. Sulphur, under the command of Captain Sir Edward Belcher . . . , during the years 1836–42, 1:7–36, 13 pls.

1867. Synopsis of the species of burrowing squirrels (Tamias) in the British Museum. Ann. and Mag. Nat. Hist., third ser., 20:434–436.

GRINNELL, J.

1908. The biota of the San Bernardino Mountains. Univ. Calif. Publ. Zoöl., 5:1–170, 24 pls. December 31.

1913. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., 3:265–390, 2 pls. August 28.

1915. *Eutamias sonomae*, a new chipmunk from the inner northern coast belt of California. Univ. Calif. Publ. Zoöl., 12:321–325, 1 fig. January 20.

1916. An analysis of the vertebrate fauna of the Trinity region of northern California. Univ. Calif. Publ. Zoöl., 12:399–410. January 27.

1917. Field tests of theories concerning distributional control. Amer. Naturalist, 51:115–128. February.

1923. A systematic list of the mammals of California. Univ. Calif. Publ. Zoöl., 21:313–324. January 27.

1933. Review of the Recent mammal fauna of California. Univ. Calif. Publ. Zoöl., 40:71–234. September 26.

GRINNELL, J., DIXON, J., and LINSDALE, J. M.

1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. Univ. Calif. Publ. Zoöl., 35, vi + 594 pp., 181 figs. October.

GRINNELL, J., and STORER, T. I.

1916. Diagnoses of seven new mammals from east-central California. Univ. Calif. Publ. Zoöl., 17:1–8, 1 fig. August 23.

1924. Animal life in the Yosemite, an account of the mammals, birds, reptiles, and amphibians in a cross-section of the Sierra Nevada (Berkeley: Univ. Calif. Press), xviii + 752 pp., 62 pls., 65 figs.

GRINNELL, J., and SWARTH, H. S.

1913. An account of the birds and mammals of the San Jacinto area of southern California, with remarks upon the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zoöl., 10:197–406, 5 pls., 3 figs. October 31.

HALL, E. R.

1930. Rodents and lagomorphs from the Barstow Beds of southern California. Univ. Calif. Publ. Bull. Dept. Geol. Sci., 19:313–318, 7 figs. November 25.

HALL, E. R., and HATFIELD, D. M.

1934. A new race of chipmunk from the Great Basin of western United States. Univ. Calif. Publ. Zoöl., 40:321–326, 1 fig. February 12.

HALL, E. R., and JOHNSON, D. H.

1940. A new chipmunk of the Eutamias amoenus group from Nevada. Proc. Biol. Soc. Wash., 53:155–156. December 19.

HINDS, R. B.

1844. Summary of the voyage. *In* The zoölogy of the voyage of H. M. S. Sulphur, under the command of Captain Sir Edward Belcher . . . , during the years 1836–42, 1:1–6.

HOLDENRIED, R.

1940. A population study of the long-eared chipmunk (*Eutamias quadrimaculatus*) in the central Sierra Nevada. Jour. Mammalogy, 21:405–411. November 14.

HOWELL, A. B.

1924. The mammals of Mammoth, Mono County, California. Jour. Mammalogy, 5:25–36. February 9.

HOWELL, A. H.

1922. Diagnoses of seven new chipmunks of the genus *Eutamias*, with a list of the American species. Jour. Mammalogy, 3:178–185. August 4.

1925. Preliminary descriptions of five new chipmunks from North America. Jour. Mammalogy, 6:51–54. February 9.

1929. Revision of the American chipmunks (genera Tamias and Eutamias). U. S. Dept. Agr., Bur. Biol. Surv., N. Amer. Fauna, 52, 157 pp., 10 pls., 9 figs. November.

1938. Revision of the North American ground squirrels, with a classification of the North American Sciuridae. U. S. Dept. Agr., Bur. Biol. Surv., N. Amer. Fauna, 56, 256 pp., 32 pls., 20 figs. May 18.

KELLOGG, L.

1916. Report upon mammals and birds found in portions of Trinity, Siskiyou and Shasta counties, California, with description of a new *Dipodomys*. Univ. Calif. Publ. Zoöl., 12:335–398, 4 pls., 1 fig. January 27.

LYON, M. W., JR., and OSGOOD, W. H.

1909. Catalogue of the type-specimens of mammals in the United States National Museum, including the Biological Survey Collection. Bull. U. S. Nat. Mus., 62, x + 325 pp.

MAILLIARD, J.

1921. Notes on the birds and mammals of Siskiyou County, California. Proc. Calif. Acad. Sci., 11:73–94. July 11.

1927. The birds and mammals of Modoc County, California. Proc. Calif. Acad. Sci., 16:261–359, 1 fig. April 27.

MERRIAM, C. H.

1886. Description of a new species of chipmunk from California (*Tamias macrorhabdotes* sp. nov.). Proc. Biol. Soc. Wash., 3:25–28. January 27.

1892. The geographic distribution of life in North America, with special reference to the Mammalia. Proc. Biol. Soc. Wash., 7:1–64, 1 pl. April.

1893*a*. The geographic distribution of life in North America. Smithsonian Report, 1891: 365–415, 1 pl.

1893*b*. Descriptions of eight new ground squirrels of the genera *Spermophilus* and *Tamias* from California, Texas, and Mexico. Proc. Biol. Soc. Wash., 8:129–138. December 28.

1897. Notes on the chipmunks of the genus *Eutamias* occurring west of the east base of the Cascade-Sierra system, with descriptions of new forms. Proc. Biol. Soc. Wash., 11:189–212. July 1.

1899. Results of a biological survey of Mount Shasta, California. U. S. Dept. Agr., Bur. Biol. Surv., N. Amer. Fauna, 16, 179 pp., 5 pls., 46 figs. October 28.

1905. Two new chipmunks from Colorado and Arizona. Proc. Biol. Soc. Wash., 18:163–166. June 29.

Miller, G. S., Jr.

1912. List of North American land mammals in the United States National Museum, 1911. Bull. U. S. Nat. Mus., 79, xiv + 455 pp. December 31.

1924. List of North American Recent mammals, 1923. Bull. U. S. Nat. Mus., 128, xvi + 673 pp.

Miller, G. S., Jr., and Rehn, J. A. G.

1901. Systematic results of the study of North American land mammals to the close of the year 1900. Proc. Boston Soc. Nat. Hist., 30:1–352. December.

Ridgway, R.

1912. Color standards and color nomenclature (Washington, D. C.: published by the author), iii + 43 + 1 pp., 53 pls.

Say, T.

1823. *In* James, E., Account of an expedition from Pittsburgh to the Rocky Mountains, performed in the years 1819 and '20 . . . , under the command of Major Stephen H. Long. 2, 422 + xcviii pp.

Stephens, F.

1906. California mammals (San Diego: West Coast Publishing Co.), 351 pp., 6 pls., 25 figs.

Sudworth, G. B.

1908. Forest trees of the Pacific Slope. U. S. Dept. Agr., Forest Service, 441 pp., 207 figs., 2 pls. October 1.

Swarth, H. S.

1919. Some Sierran chipmunks. Sierra Club Bull., 10:401–409, 3 pls.

1920. Revision of the avian genus Passerella, with special reference to the distribution and migration of the races in California. Univ. Calif. Publ. Zoöl., 21:75–224, 4 pls., 30 figs. September 11.

Townsend, C. H.

1887. Field-notes on the mammals, birds and reptiles of northern California. Proc. U. S. Nat. Mus., 10:159–241, 1 pl.

Trouessart, E. L.

1897. Catalogus mammalium tam viventium quam fossilium. Fasc. 2, Carnivora, Pinnipedia, Rodentia I (Berlin: R. Friedlander and Son), pp. 220–452.

1899. Catalogus mammalium tam viventium quam fossilium. Fasc. 6, Appendix and index (Berlin: R. Friedlander and Son), pp. 1265–1469.

1904. Catalogus mammalium tam viventium quam fossilium. Quinquennale supplementum, Anno 1904. Fasc. 2, Rodentia (Berlin: R. Friedlander and Son), pp. 290–546.

PLATE

PLATE 6

Photographs in dorsal view of one adult specimen of each species of *Eutamias* occurring in California. Natural size; photographs not retouched.

a. Eutamias alpinus, no. 23343, ♀, Colby Mtn., Yosemite Nat. Park, Tuolumne Co.

b. Eutamias minimus scrutator, no. 78558, ♀, 6 mi. E Cedarville, Modoc Co.

c. Eutamias amoenus amoenus, no. 68868, ♂, Medicine Lake, Siskiyou Co.

d. Eutamias panamintinus panamintinus, no. 27203, ♀, Johnson Canyon, Panamint Mts., Inyo Co.

e. Eutamias quadrivittatus inyoensis, no. 27302, ♀, near Big Prospector Meadow, White Mts., Mono Co.

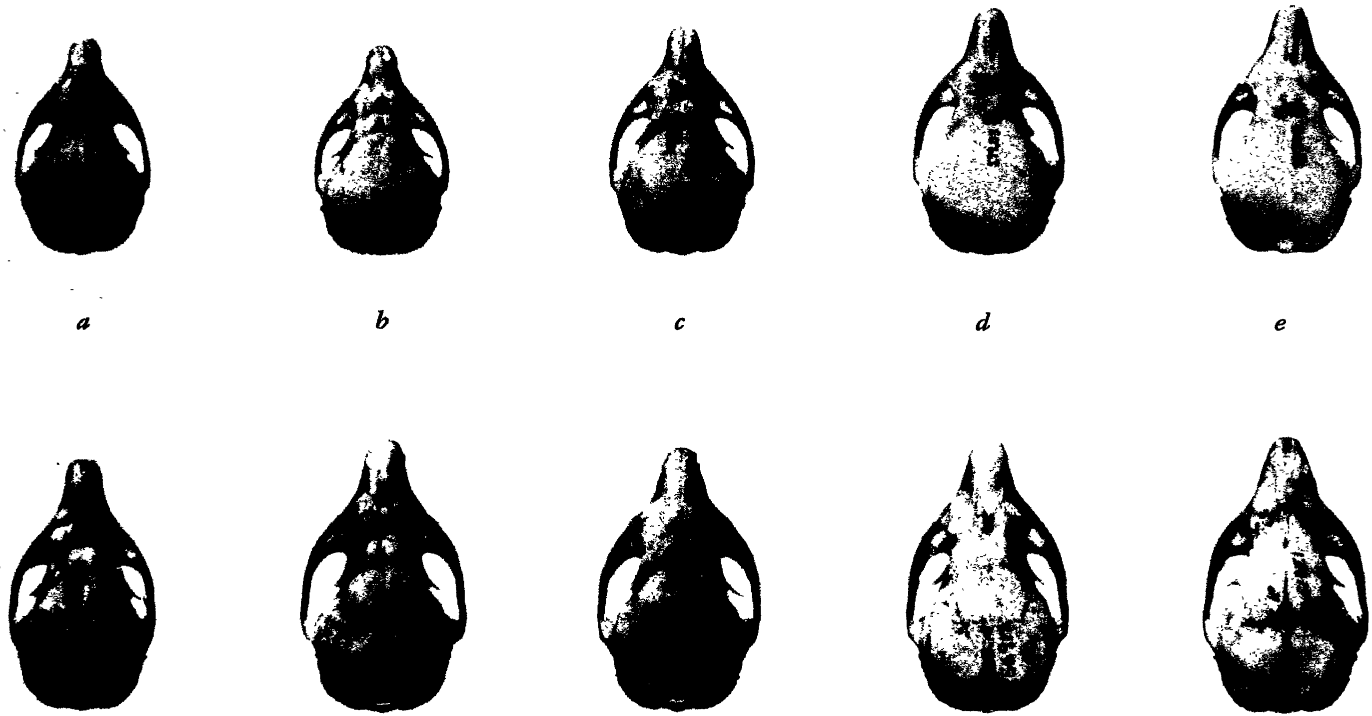
f. Eutamias speciosus sequoiensis, no. 14852, ♂, Whitney Meadow, Sierra Nevada, Tulare Co.

g. Eutamias townsendii siskiyou, no. 69160, ♀, Poker Flat, Siskiyou Mts., Siskiyou Co.

h. Eutamias quadrimaculatus, no. 22785, ♀, Merced Grove Big Trees, Mariposa Co.

i. Eutamias sonomae sonomae, no. 56912, ♂, The Racetrack, South Fork Mtn., Trinity Co.

j. Eutamias merriami merriami, no. 13815, ♂, Santa Margarita, San Luis Obispo Co.



a *b* *c* *d* *e*

f *g* *h* *i* *j*

FURTHER ANALYSIS OF A POPULATION OF THE LIZARD SCELOPORUS GRACIOSUS GRACILIS

BY

ROBERT C. STEBBINS AND HARRY B. ROBINSON

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1946

University of California Publications in Zoölogy
Editors (Berkeley): Harold Kirby, R. M. Eakin, S. F. Light, A. H. Miller
Volume 48, No. 3, pp. 149–168, plate 7, 2 figures in text
Submitted by editors December 21, 1945
Issued November 12, 1946
Price, 50 cents

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

FURTHER ANALYSIS OF A POPULATION OF THE LIZARD SCELOPORUS GRACIOSUS GRACILIS

BY

ROBERT C. STEBBINS AND HARRY B. ROBINSON

(A contribution from the Museum of Vertebrate Zoölogy of the University of California)

IN THE SUMMER of 1942 the senior author began the study of a lizard population in the Chaos Jumbles region of Lassen Volcanic National Park, California. The area chosen is a favorable one for field observations. The small amount of surface litter and the sparse vegetation combine to facilitate capture and subsequent observation of marked lizards. By frequent observation of numerous individuals in a sample section of the study area over a number of years, we hoped to gain information pertaining to territorial behavior, growth, longevity, rate of replacement of individuals in the population, interrelationships with respect to sex and age, and other matters bearing on population structure and of general interest to the naturalist.

Our study parallels work by Fitch (1940) on *Sceloporus occidentalis* and by Noble (1934) on *S. undulatus*. *S. occidentalis* typically inhabits the western Austral and Transition life-zones while *undulatus* is its eastern counterpart. In the present study, a Transition-Boreal type, *S. graciosus gracilis*, the mountain swift, is considered.

The initial survey, extending from June 23 to September 9, 1942, and information gathered by the junior author in 1943, have already been reported upon (Stebbins, 1944). Data procured by the junior author in the summer of 1944 and a study made by the senior author from July 17 to 22, 1945, are submitted here. The authors are grateful to Mr. Henry Weston who helped in the capture and observation of study animals.

MARKING

In the summer of 1942, 141 swifts were marked, digits being snipped with scissors, close to the foot, in varying combinations. To interfere with normal activity as little as possible, not more than two toes were amputated and not more than one toe was taken from any one foot. Animals thus rendered permanently recognizable did not appear to be appreciably hindered in locomotion. Differences in sex helped to distinguish individuals. In *S. graciosus*, in the absence of the typical adult coloration, sex can be consistently recognized by the size of the postanal scales. In males these scales are enlarged whereas with females they do not differ significantly in size from the surrounding scutes. This characteristic can be relied upon in sexing juveniles as well as adults. The varying combinations of sex and the missing toes served to identify the animals with a high degree of certainty.

In addition, to make possible recognition without capture, individuals were marked with indelible color. The region of the body to be marked was moistened with saliva and the color rubbed upon the scales. White, red, orange,

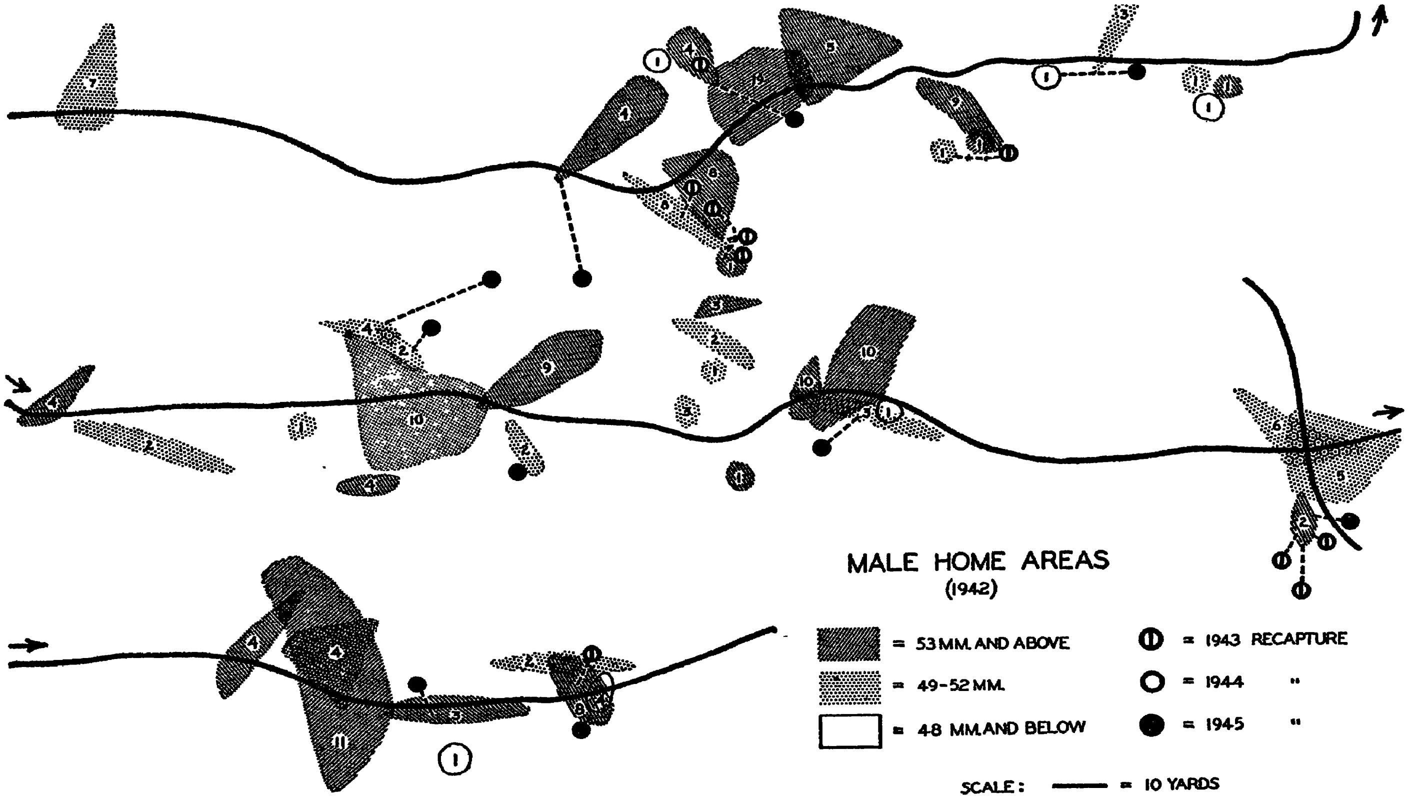


Fig. 1. Map showing the cruising or home areas of male *Sceloporus graciosus* marked during the summer of 1942. The heavy black line is the Chaos Jumbles foot trail, along which the lizards were studied, and is here broken into three parts to facilitate presentation. The figure in each area is the number of observational loci upon which area is based. Note that slight overlap occurs in areas of older male lizards. Sites of recapture, when outside the 1942 home area, are connected with it by a dotted line.

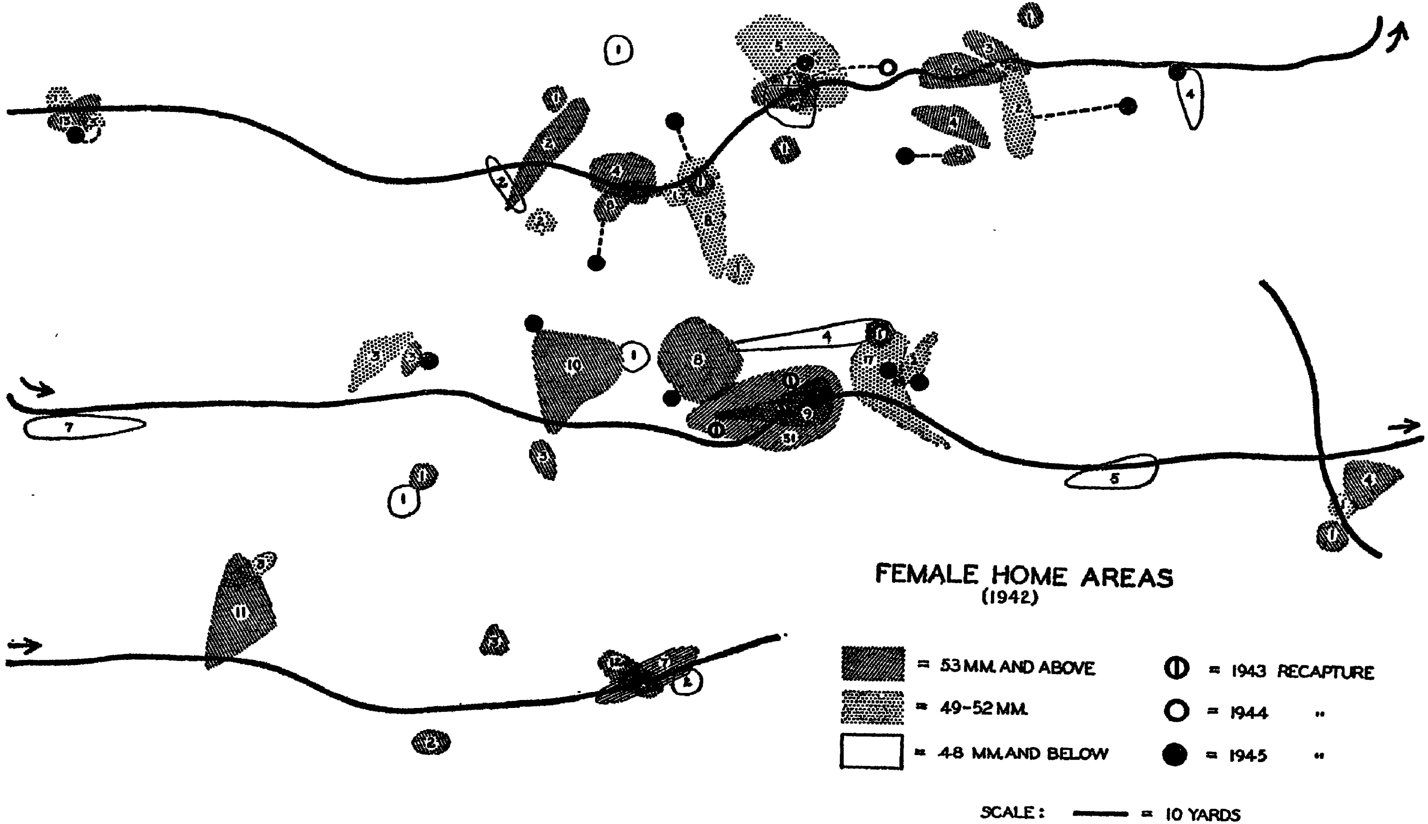


Fig. 2. Map of the same region showing zones of activity of females. Areas of males tend to be more extensive than cruising zones of females.

yellow, and pale blue were most effective. Darker shades did not show well, and green, after a few days, was difficult to distinguish at a distance from yellow. After shedding, the lizard was recaptured, measured, and the region was recolored.

STUDY AREA

The region chosen (pl. 7) is situated at an elevation of about 6,000 feet in the northwestern corner of Lassen Volcanic National Park. It consists of an avalanche-like deposit of angular, dull-colored volcanic rocks which possess a somewhat glassy groundmass.[1] This fragmental material extends in a curving tongue ½ to ¾ of a mile wide, from the base of Chaos Crags westward two miles to the Park boundary. Chaotic piles of rock occur in hummocks of varying height, from a few feet to over 50 feet. Its surface is not unlike the "knob and kettle" topography of a terminal moraine. The area is sparsely covered with conifers and scattered manzanita (*Arctostaphylos patula*), tobacco brush (*Ceanothus velutinus*), chinquapin (*Castanopsis sempervirens*), and ocean spray (*Holodiscus discolor*). The only relatively abundant herbaceous plant is a silvery-leafed lupine (*Lupinus obtusilobus*). (For a more detailed description of the habitat see Stebbins, 1944.) Lizards were common here. Those marked for study were captured in the vicinity of a trail passing through the area. The study section embraced a region roughly 1200 yards in length and somewhat over 100 yards in width. It is believed that nearly all the lizards in the section were marked by the end of the 1942 study period. The area had been examined several times daily, with few exceptions, for 2½ months, toward the end of which few unmarked animals were found.

HOME AREAS

As in other species of *Sceloporus* studied by Fitch (1940) and Noble (1934), individuals of *S. graciosus* were found to occupy specific places within the habitat. We could quite accurately predict the identity of our study animals by their location, regardless of their age or sex, although males were identified less consistently than females. As Fitch found in *S. occidentalis*, males move about more than females, a difference in behavior probably based upon more intense territorial pressures among them. A tabulation of the greatest linear dimension of the areas utilized by 38 adult and subadult *graciosus* showed that the areas of the males averaged 82.1 feet, whereas those of the females averaged 59.0 feet. The maps (figs. 1 and 2) give the location of the cruising area of each lizard marked in 1942, with the exception of the young of that season. The number of loci upon which the home area of any individual is based is indicated by the figure within the area. Obviously, where an individual was seldom observed, the limits of his zone of activity cannot be given. One can assume only that it lies in the vicinity, and its position in relation to the home areas of other lizards can be approximately determined, for areas of individuals were repeatedly observed to be narrowly circumscribed. For clarity, areas occupied by males and females are shown in separate maps, readily compared. Individuals also have been segregated according to size.

[1] Williams (1928, p. 263) describes the deposit as a torrential volcanic breccia. The reader is referred to this paper for details concerning its origin.

During the five days of intensive work in the area in 1945, twenty-two animals marked in 1942 were recaptured. Ten were males, twelve were females, and of course all were fully adult. All these animals were found within or near home areas recognized in 1942, and the points of recapture are shown. However some lizards seemed to have shifted their center of activity somewhat. In table 1 the distances between the initial marking site and the places of recapture are given.

TABLE 1

THREE-YEAR GROWTH AND MOVEMENT OF INDIVIDUALS OF SCELOPORUS

Size (in mm.)				Distance from original marking site (in ft.)		
1942	1943	1944	1945	1943	1944	1945
			Males			
55	..	..	55	..	..	85
54	..	..	54	..	..	..
55	55	..	..	4	..	..
54	..	..	54	..	..	70
47–52	..	..	54	..	..	73
51	..	..	58	..	..	50
48–50	52	..	..	35	..	..
51–52	..	..	52	..	..	45
53–55	..	..	55	..	..	73
56	56	..	..	45	..	..
51	..	..	53	..	..	14
53	53	..	55	23	..	30
49–53	..	..	54	28	..	15
.....	37	..	56	..	..	75
52–55	55	..	56	..	..	..
			Females			
51	..	..	55	..	..	..
53	..	..	56	..	..	12
53–56	..	..	57	..	..	35
50–51	..	..	55	..	..	..
55–57	..	..	57	..	..	4
46–52	..	..	55	..	..	same location
26	35	..	..	50	..	..
55	..	..	55	..	..	30
42–50	..	..	55	..	..	30
40–46	..	..	52	..	..	same location
55	55	..	..	same location	..	..
52	..	..	55	..	..	10
53	..	..	56	..	..	34
49	..	..	55	..	..	same location
.....	55	55	57	..	15	30
.....	35	..	50	..	..	43
.....	..	57	57	..	..	22

Of the 22 recaptured animals, 7 had reached maximum size in 1942. Completion of growth in the minimum period of two years is exceptional, for these lizards usually require three and sometimes four or more years. Therefore, the 7 individuals were at least five years old in 1945. The majority were probably six years of age and some may have been older. Thus, we feel justified in concluding that many, if not all, mountain swifts spend their entire lives within closely circumscribed areas, some less than 100 feet across. This conforms to the observations made by Fitch on *S. occidentalis*.

We were interested in how newly hatched juveniles established themselves among the older animals. Since adults, subadults, and juveniles often occupied essentially the same area, it seemed likely that, except for well-filled or overpopulated sectors the young would tend to become established close to the hatching site. The limited data available support this view. Records of several newly hatched young of 1942 follow: (1) A juvenile female, 26 mm. from snout to cloaca, marked on September 2, was a recently hatched individual, no doubt not far from its birthplace when marked. It was recaptured on July 31, 1944, almost two years later, 31 yards from the original site. (2) A second juvenile, a female 26 mm. in length, marked on September 6, 1942, was recaptured on August 21, 1943, 17 yards from the original marking site. (3) A newly hatched juvenile, marked on August 24, 1942, and subsequently observed the same season, tended to remain in the vicinity of the marking site. On September 2 it was seen 21 yards from the original location; on the 3d, 25 yards; and on the 6th it was back within 6 yards of this site.

Observations made since the earlier report on *Sceloporus graciosus* support the original conclusions and may be summarized as follows: (1) Individual lizards, regardless of age or sex, occur consistently in rather well-circumscribed places within the habitat. However, some gradual shifts in these home areas may occur from year to year or even during a single season. These movements are probably connected with responses to environmental conditions such as seasonal changes in the amount of insolation, food supply, places of refuge, and intraspecific pressures. However, a wandering tendency does not appear to be present. (2) There is usually a portion of the home range in which the animal is most frequently observed—a center of activity. Optimum food and shelter in this preferred sector are probably the attracting factors (pl. 7, fig. 2). (3) The home ranges of adult individuals of the same sex may overlap or even be superimposed (figs. 2 and 3), but superimposition of adult male areas is less common than adult female areas. The spheres of activity of males commonly embrace those of females. The intensity of the defense of territories in adult males has not been determined since all observations have been made after the nuptial period. (4) Individual males and females often occupy about the same area and are frequently found in the company of one another. These associations may occur even long after the breeding period. Subadults and juveniles of both sexes are tolerated within the home range of adults.

NUPTIAL BEHAVIOR

The only sexual activity observed is probably to be interpreted as postbreeding behavior. On June 23, 1942, a stout-bodied adult female, seemingly gravid, was approached by an adult male. The male came forward in short jerks, with quivering muscles, in the manner described for courting males of *S. occidentalis* by Fitch (1940). The female responded by arching her back, compressing her body, lowering her head, and elevating her tail, which was swung to one side. The male then ceased his approach. A few days later, on June 30, a second stout-bodied female was seen to discourage two males in a similar fashion. No other nuptial behavior was observed during the 1942 season.

Fitch (1940), in disagreement with Noble and Teale (1930), holds that this pose assumed by the female *Sceloporus* serves to discourage courting males and at the same time advertises her sex, thereby preventing the male from defending his territory against her. Our observations on *S. graciosus* support this view.

REPLACEMENT IN THE POPULATION

Fitch (1940) found that of an original group of 36 *S. occidentalis* marked in June, 1933, at Dark Hollow, Medford, Jackson County, Oregon, 83 per cent had been replaced by May, 1934. Again, in May, 1935, he found that of an original 52 lizards present in 1934, 80 per cent had disappeared. In view of these results, our findings with *S. graciosus* are surprising. Of a total of 63 animals of all sizes captured during the five-day study period in July, 1945, 22 (34.9 per cent) were animals marked in 1942. One may assume from this sampling that after three years one-third of the original population was still present. The young are not included in this calculation since few were marked in 1942. Of Fitch's animals, one-fifth or less[2] were found after the lapse of only a year. The percentage of recaptures of marked *S. graciosus* would have been still higher had the young of the year been marked in 1942.

Of the twenty-two marked animals of 1942 recaptured in 1945, seven had shown no growth. These lizards must have been in their third year of life when marked inasmuch as cessation of growth normally does not occur before then. Thus, they were probably six years of age, and they constituted 31.8 per cent of the animals recaptured. If this ratio can be relied upon as indicating the proportion of these older animals in the surviving elements of the 1942 population, about one out of every three lizards of the original marked group had a potential life span of at least six years.

Fitch found in populations of *S. occidentalis* that the adults of one season were largely replaced the following year by young. The life expectancy of this lizard in the areas studied by him is, therefore, quite short. Only one individual was known to have reached an age comparable with our older animals. This one was judged by Fitch to be nearly six years old when last seen. He believes that most are victims of predation. In the areas he studied the yellow-bellied racer (*Coluber constrictor mormon*), Pacific rattlesnake (*Crotalus viridis ore-*

[2] This figure may be somewhat low. Fitch states that some of the replaced lizards may still have been alive, having moved elsewhere.

ganus), king snakes (*Lampropeltis multicincta* and *L. getulus*), garter snakes (*Thamnophis ordinoides* ssp.), gopher snake (*Pituophis catenifer*), sparrow hawk (*Falco sparverius*), and small mammals either have been found to be predators or are suspected of predation.

In Lassen National Park, *S. graciosus* lives near the upper altitudinal and lower thermal limits for reptiles. Competition with other reptilian species is slight, the only other reptiles known from the area being a species of alligator lizard (*Gerrhonotus coeruleus*) and the Pacific red-sided garter snake (*Thamnophis sirtalis tetrataenia*). Both frequent damp localities and were never seen well out on the arid Jumbles where the swifts were most common. In marginal areas, near the few small streams and ponds, garter snakes were seen in regions occupied by *Sceloporus*. No doubt some lizards are taken by this snake, but death through predation by reptiles is probably uncommon.

Avian enemies may be more important. The relative scarcity of plant cover exposes the animals to attack from above. One lizard possessed a well-defined V-shaped scar across its shoulders which probably resulted from an attack by a bird. Still, in our extended study of the area, no predation of this sort was observed. Although sparrow hawks, a likely enemy, were often seen in the vicinity of Lassen Peak, we never recorded one over the Jumbles, but they probably occur, though apparently not abundantly. Steller jays may prey upon the swifts, but they are not common in the sparsely timbered areas where the lizards flourish. Golden-mantled ground squirrels, chipmunks, and chickarees are present in the more heavily wooded areas but here the swifts are less common. These or other mammals may occasionally take lizards.

Our impression is that death through predation may be secondary to that stemming from physical factors. The rigors of the winter, during which snow may cover the area for six months at a time, would seem to militate strongly against survival of the callow young. In coping with low temperatures approaching lethal levels, older animals familiar with their home areas, that is, the burrows, crevices, and other channels which provide adequate retreat in depth from falling temperatures, would appear to possess a distinct advantage over the inexperienced young. On the side of predation, as Fitch points out, experience in escaping from one type of predator would be of little value in escaping another kind, since methods of hunting are so diverse; there would be a less marked difference between chances of survival of young and adults.

We feel then that fewer predators and the possible premium placed on experience in retreating from low temperatures make for a larger proportion of older adults in the population as a whole than may be found in species occurring at lower altitudes such as *S. occidentalis*.

Severe weather may have caused differences between the subadult-adult ratios for 1942 and 1945. In 1942, 67 out of 99 animals captured (67.7 per cent) were adult (over 50 mm. long). Lizards below this arbitrary size, exclusive of the season's young, were considered subadults; 18 of the 99 were 45–49 mm. in length, and 14 were 32–44 mm. Thus there were 2 adults captured to every subadult. In 1945, during the five-day study period, of 56 lizards captured 33 (59 per cent) were adults. The differences between the ratios in

the two seasons may be related to weather variation such as is suggested by Table 2.

The weather statistics indicate that prior to the 1942 study there had been three years of heavy snowfall, culminating in the heaviest annual fall in 18 years during the winter of 1940–41; 1941 was likewise the cloudiest in 15 years. The reproductive activities of the swifts must have been depressed; the young probably emerged late in the season and were then beset by another hard winter. On the other hand, snowfall in 1944 and 1945 was somewhat below average, and that in 1943 was not severe. The 1.5 to 1 ratio of adults to sub-adults in 1945 is probably about normal.

TABLE 2

Records of Snowfall in Lake Helen Basin, Lassen Volcanic National Park[a]

Date	Snow depth (inches)	Water content (inches)	Density (per cent)
April 2, 1940....................	232.2	110.3	47.5
April 8, 1941[b]....................	287.1	134.5	46.8
April 9, 1942....................	190.7	92.5	48.0
April 1, 1943....................	193.9	90.6	46.7
April 1, 1944....................	114.6	51.0	44.5
April 6, 1945....................	170.8	72.6	42.5
Average, 1931–1945..............	171.8	79.1	45.6

[a] The Lake Helen Basin is at an elevation of 8,164 feet in the southwestern part of the Park. Records were prepared by H. Robinson.
[b] Heaviest annual precipitation (71.9 inches) in 18 years and greatest number of cloudy days (132) in 15 years at the Mineral Station, 4,905 feet, Mineral, Tehama County.

Fitch considers it likely that in *S. occidentalis* the young normally outnumber the adults at all times of the year. Year-old young which he recorded in August and September were grouped with the adults, since they often cannot be distinguished in the field. Although records of percentages of young to adults did not fully bear this out, he points out factors responsible for distortion of these data. The small size of the young, their scattered distribution away from the usual habitats, and their proclivity for remaining on the ground in inconspicuous places make them less likely to be seen.

In our study of *S. graciosus* we were impressed with the relative scarcity of smaller lizards in the population as compared with fully grown individuals. Except during the hatching period in late August and September it is doubtful if the young ever outnumber the adults. Even when lizards over one year old are included as young, the ratio is still in favor of the adults. In determining the proportion of young to adults, we have counted all lizards below 50 mm. in snout to cloaca length as young, although those approaching 50 mm. are ordinarily around 2 years old and some may be reproductively active. The reproductive rate in the two species in the areas studied is markedly different. The lizards at Lassen averaged 3.33 eggs per gravid female; the range for 10 individuals was from 2 to 5 eggs. *S. occidentalis* averaged 8.5 eggs per gravid female; the range for 8 individuals examined by us was from 6 to 10 eggs.

Seven gravid females collected near Berkeley, California, by Fitch, averaged 13.7 eggs.

Our ratios of young to adults may be, like Fitch's, somewhat distorted, but they are less so than his, we feel, in view of these facts: (1) Scarcity of surface litter and understory vegetation facilitated our observation. (2) Our method of shuttling back and forth over the study area, thereby thoroughly covering it nearly every day, promoted exhaustive observation. In 1942 our surveys were made at least twice a day (with a few exceptions) and sometimes more often, throughout the period of study. Furthermore, they were usually made in the morning, sometimes during midday, and again in the late afternoon, thereby minimizing possible inaccuracies due to differences in time of activity between young and adults—a difference notably affected by the relationship of the surface-mass ratio to temperature, as Cowles (1941) and others have pointed out.

Although the scarcity of young lizards might at first appear incompatible with the maintenance of a constant population level, it must be remembered that the adults are long-lived. *S. graciosus*, while producing fewer young per season than *occidentalis*, reproduces longer and hence achieves essentially the same result.

FEEDING HABITS

In a cursory examination of the digestive tract of six *Sceloporus graciosus* taken in 1942, carpenter ants (*Camponotus* sp.), ladybird beetles, and parasitic roundworms were found, the nematodes being in all the stomachs. As a further check on feeding habits, 15 individuals were examined in 1945 for food remains and parasitism (see table 3). In all lizards investigated, small rocks of varying sizes were mixed with the food. These particles probably aid materially in dismembering the hard chitinous bodies of arthropods eaten. Many of the rocks are swallowed accidentally in feeding, but it is possible some may be deliberately ingested.

Nine of the 15 lizards examined (60 per cent) were parasitized by helminths. All 9 had roundworms and four had tapeworms as well. The nematodes were of two types: a slender white species (*Skrjabinoptera phrynosoma*), the largest of which was 12.2 mm. in length, found only in the stomach; and a sausage-shaped, whitish one, a species of the genus *Pharyngodon*, about 4 mm. in length, found in the rectum. The tapeworms were found in the upper intestine. In one lizard, a cluster of seven, each about 26 mm. long, was found in a tangled mass about one-third the distance from the pyloric valve to the rectum; the intestine in this region was markedly dilated. In another lizard, a single tapeworm, 60 mm. in length, lay outstretched for most of the length of the intestine. A portion of its body was coiled on itself. The scolex was a short distance below the pyloris. Even the most heavily infested lizards did not appear to be emaciated, but seemed as well-nourished and healthy as nonparasitized specimens. Two of the nonparasitized individuals were probably less than one year old, since they were 30.6 and 36.1 mm. in snout–cloaca length. Probably individuals of this age are lightly or not at all parasitized by helminths.

TABLE 3

GASTROINTESTINAL CONTENTS OF SCELOPORUS

Size	Food										Parasites			
											Nematoda[b]			
	Carpenter ants (*Camponotus*)	Other ants	Wasps	Hemiptera	Lepidopterous larvae	Ladybird beetles	Other beetles	Robber flies	Grasshopper nymphs	Spiders	*Skrjabinoptera phrynosoma*		*Pharyngodon* sp.	Cestoda
Males:											*stomach*	*intestine*	*rectum*	
53.9.....	10	..	..	..	..	1	..	..	..	..	5	0	0	3
55.7.....	9	2	..	..	..	..	..	..	..	..	16	2	0	0
55.2.....	22	..	..	1	..	..	2	..	..	1	1	0	0	1 (60 mm.)
51.8.....	2	..	1	..	..	..	..	1	..	1	0	0	0	0
52.2.....	11	..	..	..	..	..	..	..	..	..	12	0	3	0
30.6.....	..	..	..	..	1	..	..	..	..	..	0	0	0	0
54.6[a]....	..	..	..	..	..	..	..	..	..	..	5	0	0	3
Females:														
57.9.....	many	..	..	..	1	..	..	..	..	..	0	0	0	0
55.3.....	many	some	..	..	1	2	..	..	..	2	0	0	0	0
58.2.....	11	..	..	..	..	1	..	..	..	1	20	0	0	0
45.4.....	few	2	..	..	..	..	..	..	..	1 with egg case	0	0	0	0
45.2.....	6	3	..	..	2	..	1	..	1	..	2	0	0	0
45.7.....	7	..	..	..	..	..	..	..	..	1	0	2	0	0
45.8.....	12	..	..	..	..	..	..	..	..	..	0	0	3	7
36.1.....	2	..	..	..	..	..	..	..	..	1	0	0	0	0

[a] Stomach empty; a few ants in intestine.
[b] We are indebted to Dr. A. C. Walton for the identification of these parasites.

MOLTING

In the study period from June 23 to September 9, 1942, most of the larger lizards molted but once, usually in late July and in August. No adult was known to have molted prior to July 15, 1942, nor later than August 25–30; observations ended September 9, 1942. It is likely that many adults molt but once a year; some, however, shed several times. A male, 51 mm. in length, shed once between July 9 and August 3, and again by August 18. Incidentally, this individual was regenerating its tail. This raises the question, might the accelerated metabolism associated with a rapidly growing tail in some way promote exuviation? The time of molting in adults was not regular; records of shedding were widely scattered between the dates mentioned. Three younger lizards shed several times during the 1942 study period (see table 4).

In the shedding directly observed, the old skin was fragmented and was never shed as a single piece, as in certain smooth-scaled lizards such as members of the genus *Gerrhonotus*. In three adults, the old skin had been lost on the head, the line of rupture passing from behind the eyes, diagonally forward on the sides of the head, and across the throat. The remaining old skin was still intact. Perhaps the process is often begun by the action of the "swell" mechanism (Bruner, 1907), which, through protrusion of the eyes and swelling at the external nares, starts the loosening of the head skin. In another adult,

most of the skin of the body had been lost but that on the head was intact; the skin of the limbs was loose but still in place. Still another individual which was regenerating one third of its tail had shed the tail skin, although the remainder of the integument was unbroken. Shedding seems to follow no well-defined pattern in this species.

TABLE 4

SHEDDING IN YOUNG SCELOPORUS

Specimen	Shedding dates	Growth	
		Length, in mm.	Date
1	1. July 9–29	32	July 9
	2. July 29–August 3	43.5	August 24
	3. August 13–24		
2	1. July 9	40	July 9
	2. July 21–August 11	45	August 11
3	1. July 9–August 11	42	July 9
	2. August 26–30	47	August 11
		50	August 30

TAIL REGENERATION

Of 133 animals marked in 1942, 1943, and 1944, 20 individuals (15.8 per cent) showed varying degrees of regeneration of the tail, as will be seen in table 5. A regenerating tail is at first gray with a smooth skin. As the tail increases in length it becomes darker and soon develops a fine, granular scalation. Later these granular scales become modified, developing keels and resembling those of the remainder of the tail, though they are smaller and shorter. The new tail lacks the color pattern of the old structure.

DISCUSSION AND SUMMARY

A population of 141 mountain swifts, *Sceloporus graciosus gracilis*, marked in the summer of 1942 in the Chaos Jumbles area of Lassen Volcanic National Park, was reëxamined during a 5-day study period from July 17 to 22, 1945. This study forms the basis for the following statements:

(1) Close to ⅓ (34.9 per cent) of the original group was present after three years. This conclusion is based on a random sampling of the population in 1945. Of a total of 63 animals captured, 22 were lizards marked in 1942.

(2) One out of every three lizards of the original group of 1942 had a life expectancy of at least six years. This ratio is based on the number of individuals recaptured in 1945 that had shown no growth since 1942. Three years is normally required for full growth.

The replacement rate in the population and the life span of the montane *Sceloporus graciosus gracilis* stands in marked contrast with that of the lowland *Sceloporus occidentalis* studied by Fitch (1942). Less than ⅕ of his original group was present after one year, and only one of his animals was thought to have approached six years of age. The following factors may be connected

TABLE 5

Tail Regeneration

Specimen number	Date	Body length (in mm.)	Length of remainder of original tail (mm.)	Amount of regeneration (mm.)
Males:				
5	June 23, 1942	53	10	0.0
	July 8, 1942	....	....	9.0
	July 20, 1942	....	....	18.0
	August 3, 1942	....	....	24.5
	August 13, 1942	55	....	27.0
35	August 3, 1942	51	....	5.0
	August 18, 1942	53	....	14.3
60	July 15, 1942	48	....	6.5
	August 18, 1942	50	....	19.5
	September 1, 1942	50	....	missing
71	July 20, 1942	53	....	19.0
	August 13, 1942	53.5	....	29.0
74	July 22, 1942	51	....	20.0
	August 12, 1942	51.5	....	21.7
	July 20, 1945	53	....	25.0
69	July 18, 1942	52	....	0.0
	August 18, 1942	55.3	....	4.5
78	August 20, 1942	54.5	....	0.0
	July 21, 1945	55.0	38.0	8.0
23	August 27, 1942	49.7	....	0.0
	July 20, 1945	54.0	41.0	9.0
150	September 3, 1943	37.0	....	0.0
	July 20, 1945	56.0	31.0	37.0
Females:				
72	July 20, 1942	56.0	....	19.0
	July 22, 1942	56.0	....	19.5
47	August 17, 1942	57.5	....	0.0
	July 18, 1945	57.5	20.0	24.0
91	July 30, 1942	50.0	19 (40 mm. removed)	0.0
	August 24, 1942	52.5	....	8.0
92	August 3, 1942	55.0	....	31.0
	August 24, 1942	55.0	....	31.5
36	July 21, 1944	55.0	....	0.0
	July 19, 1945	57.0	16.5	24.0
84	July 30, 1942	52.0	40 (21 mm. removed)	0.0
	July 19, 1945	55.0	44.0	9.0
142	August 25, 1943	55.0	....	0.0
	July 19, 1945	57.0	33.0	3.0
155	July 31, 1944	57.0	....	0.0
	July 19, 1945	57.0	29.0	9.0

with the slower replacement in the population and the greater longevity in *S. graciosus:*

(a) Fewer enemies.

(b) Shorter yearly period of activity, reducing time of exposure to predation. Active period of *Sceloporus graciosus* at Lassen from five to six months; of *Sceloporus occidentalis* at Berkeley, eight or more months.

(c) Fewer young.

The greater longevity and slower change in the components of the population balance the slower reproductive rate in this species. *Sceloporus graciosus* averaged 3.33 (10 individuals examined from the Lassen area) eggs per clutch, whereas *S. occidentalis* averaged 8.5 (8 individuals examined from various parts of the range of the species). Although the former species produces less than ½ the number of eggs of the latter, individual females live to reproduce over a greater number of years, at least in the areas studied.

(3) Individual lizards spend their entire lives within closely circumscribed home areas. These areas appear to be established at or near the hatching site. They may be displaced somewhat through intraspecific pressures and other factors, but extensive wandering does not occur.

It is well to call attention here to the importance of home areas in relation to the rate of gene spread through the population. A population whose breeding units are sedentary, other things being equal, tends to differentiate more rapidly than one in which new genes are freely distributed by widely ranging individuals. *Sceloporus graciosus* is such a sedentary type.

The greater length of life of individual lizards would likewise tend to promote local differentiation. On the other hand, the slower reproductive rate would operate in a reverse direction. It is likely that close study of variation in this species would reveal numerous local differences as has been found for several species of *Bufo* by Blair (1943).

The Chaos Jumbles is an area 2 miles long by ½ to ¾ of a mile wide. The avalanche-like debris of which it is composed is estimated to be about 200 years old (Williams, 1928, p. 262). This calculation is based, among other things, on tree-ring studies. It is worth noting that the area has become extensively populated with lizards during this period. The cataclysm that formed the Jumbles was certainly of such violence that ground-inhabiting species of this sort must have been eliminated.

(4) The digestive tracts of 15 individuals contained the following food items, listed in descending order of abundance: carpenter ants (*Camponotus*), other ants, spiders, beetles, lepidopterous larvae, bugs, robber flies, grasshoppers. Only one each of the last three items was found. One individual had eaten leaves of an unidentified plant.

(5) Nine lizards of 15 examined in 1945 were parasitized by helminths. All infested lizards harbored nematodes: 8 had *Skrjabinoptera phrynosoma* and 2 a species of the genus *Pharyngodon*. Four had tapeworms as well.

(6) Adult mountain swifts, on the average, probably molt a single time each year, usually in late July or in August. Some adults were known to have shed more than once. Subadults and juveniles commonly molt several times.

LITERATURE CITED

Blair, A. P.
1943. Geographical variation of ventral markings in toads. Amer. Midl. Nat., 29:615–620.

Bruner, H. L.
1907. On the cephalic veins and sinuses of reptiles, with description of a mechanism for raising the venous blood pressure in the head. Amer. Jour. Anat., 7:1–117.

Cowles, R. B.
1941. Observations on the winter activities of desert reptiles. Ecology, 22:125–140.

Fitch, H. S.
1940. A field study of the growth and behavior of the fence lizard. Univ. Calif. Publ. Zoöl., 44:151–172.

Noble, G. K.
1934. Experimenting with the courtship of lizards. Nat. Hist., 34:3–15.

Noble, G. K., and H. K. Teale
1930. The courtship of some iguanid and teiid lizards. Copeia, 54–56.

Stebbins, R. C.
1944. Field notes on a lizard, the mountain swift, with special reference to territorial behavior. Ecology, 25:233–245.

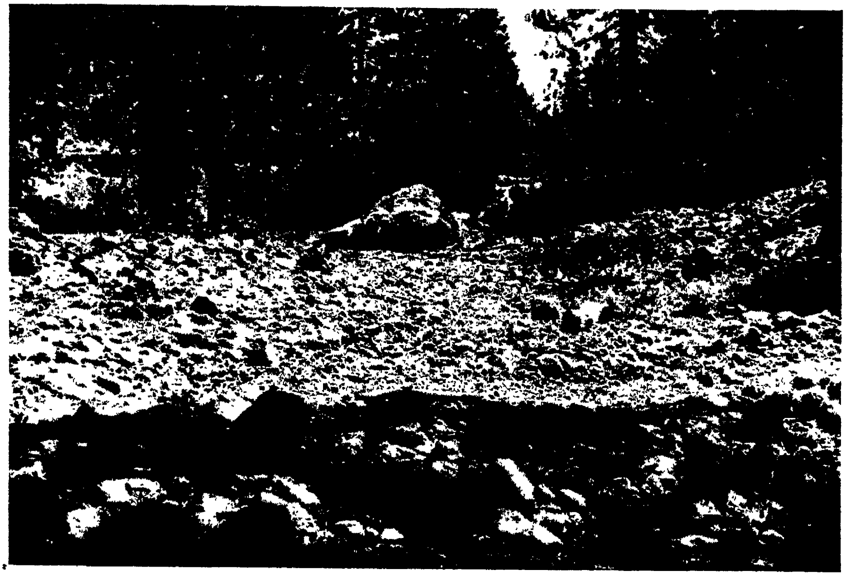
Williams, H. W.
1928. A recent volcanic eruption near Lassen Peak, California. Univ. Calif. Publ. Zoöl., 17:241–263.

PLATE

PLATE 7

Fig. 1. A well-populated section of the rocky Chaos Jumbles habitat of *Sceloporus graciosus*. A 3-year-old adult female marked in the vicinity of the large rock in the background, July 7, 1942, was recaptured within four feet of this rock on July 18, 1945. Surface litter and understory vegetation are scanty in the study area.

Fig. 2. A station of one lizard was this disintegrating pine log, probably favored for the insects and other arthropods it harbored and the shelter it afforded. Such debris is not abundant in the sparsely timbered Jumbles area.



1

2

VARIATION IN THE SKINKS (REPTILIA: LACERTILIA) OF THE SKILTONIANUS GROUP

BY

THOMAS L. RODGERS AND HENRY S. FITCH

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1947

University of California Publications in Zoölogy
Editors (Berkeley): Harold Kirby, R. M. Eakin, S. F. Light, A. H. Miller

Volume 48, No. 4, pp. 169–220, plates 8–10, 9 figures in text

Submitted by editors May 22, 1946

Issued May 29, 1947

Price, $1.00

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

VARIATION IN THE SKINKS (REPTILIA: LACERTILIA) OF THE SKILTONIANUS GROUP

BY

THOMAS L. RODGERS AND HENRY S. FITCH

(A contribution from the Museum of Vertebrate Zoölogy of the University of California)

INTRODUCTION

In undertaking the study of the *skiltonianus* group of skinks our aim is to define more clearly than was possible heretofore the forms that are included within it. Our interest was directed to the problems inherent in these lizards by the appearance of Taylor's (1935) revision of the genus *Eumeces*, from which it was apparent that the relationships between *Eumeces skiltonianus* and its neighboring forms in western North America remained obscure. Material was then almost entirely lacking from extensive areas where skinks might be expected to occur, and the most critical areas lay almost entirely in California—within a practical working range. It was thought that extensive and carefully directed collecting of specimens would yield a much improved understanding of the whole group.

Field work was begun by Fitch in 1937 and in later seasons was shared by both of us. Five to eight trips of one to three days each were made each year, a majority of them by Fitch. A total of 752 skinks was collected (420 by the authors) from 80 different localities. These and approximately 580 examples already available in collections were used in this study. Recording and summarization of data from the specimens was done entirely by Rodgers. Illustrations unless otherwise credited are by Rodgers.

Large gaps between the known ranges of the forms were eliminated by the collection of successive samples between the nearest known points of occurrence until the forms were traced to within a few miles of each other; intergradation or lack of it was thus demonstrated. In this manner the 200-mile gap between the range of *E. gilberti*, in the Yosemite region, and that of *E. skiltonianus*, in the region about Lassen Peak, was closed by a few days' collecting. Likewise the occurrence of skinks was traced from the San Francisco Bay region to the Tehachapi Mountains through the inner Coast Ranges where they had not been recorded before.

Although the new series thus assembled have made possible a better analysis of the characters, distribution, and relationships of the several kinds of skinks, as is usually true in a study in systematics, the material has not been sufficient to solve all problems arising. The conclusions herein set forth undoubtedly will be subject to modification as more material becomes available from areas in which the populations of skinks have not been thoroughly sampled.

The authors wish to thank the following persons for the privilege of borrowing specimens for use in this study: Dr. L. M. Klauber, San Diego Society of Natural History; Mr. Joseph Slevin, California Academy of Sciences; Dr.

George Myers and Miss Margaret Storey, Stanford Natural History Museum; Dr. H. K. Gloyd, Chicago Academy of Sciences; Dr. R. B. Cowles, University of California, Los Angeles; Dr. John A. Comstock, Los Angeles Museum; Dr. I. D. Nokes, 1120 Rives-Strong Building, Los Angeles, California. We wish to thank the following persons for making special effort to collect valuable material especially for this study, all of which is now part of the collections of the Museum of Vertebrate Zoölogy: Mr. Sherburne Cook, Jr., Mr. Walter W. Dalquest, Mrs. Alice Kerr Delwiche, Mr. F. E. Haas, Mr. Albert C. Hawbecker, and Miss Frances Prack. Also, we express our appreciation of the patient counsel and constructive criticism and editing of Dr. Alden H. Miller, Director of the Museum of Vertebrate Zoölogy.

REVIEW OF CLASSIFICATION

The earliest name applied to any of the Pacific Coast skinks was *Plestiodon skiltonianus* (Baird and Girard, 1852); it related to specimens collected near The Dalles, Oregon. The specific name *skiltonianus* was thenceforth generally accepted for the wide-ranging western skink, and only two synonyms were created for it: *Eumeces quadrilineatus* Hallowell 1853, and *Eumeces hallowelli* Bocourt, 1879. Skinks from the Pacific Coast were classified as a single species until 1895, at which time Van Denburgh described a new species, *Eumeces lagunensis,* on the basis of two specimens from southern Lower California. The next year, he described another new species, *Eumeces gilberti,* basing it on a series of specimens from the region of Yosemite National Park, and he showed that the new species was set off from the species *skiltonianus* by trenchant characters, namely, much larger adult size, metamorphosis of color pattern with loss of body stripes, and different position of stripes in small young.

In 1900, Cope named the form *brevipes* as a "variety" of the species *skiltonianus,* which differed from the typical form in larger size, relatively short limbs, and olive dorsal coloration with no distinct stripes. The type locality of *brevipes* was Fresno, California. The name was generally considered a synonym of *skiltonianus.*

In 1935, Taylor in his revision of the genus *Eumeces* made extensive changes in the classification of this group of skinks. He resurrected the name *gilberti,* which had been thrown into synonymy as representing merely a "local phase" of *skiltonianus.* In taking this action Taylor justified his course by redefining the species *gilberti,* indicating additional distinctive and fairly constant characters of scalation and pattern setting it off from *skiltonianus* and affirming the systematic value of the original characters of size and pattern which had been questioned by Camp (1916). Taylor demonstrated that a population of large skinks resembling typical *gilberti* in most characters, but strikingly different from it in the red or pink rather than blue tails of juveniles, ranged through the southern Sierra Nevada and the Tehachapi Mountains and southward into San Diego County. He recognized these pink-tailed skinks as a distinct and new subspecies and applied the name *rubricaudatus* to them.

A small series of skinks from the northern Sierra Nevada which seemed to

differ somewhat from any other population was regarded by Taylor as representing a distinct subspecies of *skiltonianus*. For this form Taylor used the name *brevipes* (Cope, 1900), although the type *brevipes* came from Fresno, some 200 miles farther south, and the intervening region is occupied by the species *gilberti*.

Within the range of the subspecies *skiltonianus*, Taylor's extensive data show that geographic variation occurs in several characters of lepidosis and that local populations from geographically remote portions of the range may differ from each other markedly in some respects.

While Taylor's revision thus resulted in a much better understanding of California skinks and increased the recognized forms from two to four, it still left many problems unsolved. Taylor stated (1935: 414), "My conclusions which are here expressed are tentative. They represent my solution of certain problems; but due to lack of material I leave certain problems unsolved to my own satisfaction." The relationships of *gilberti* and *rubricaudatus* to *skiltonianus* and to each other were not satisfactorily determined.

In assigning the name *brevipes* to his new race in Eldorado County, Taylor wrote (1935: 431): "Insomuch as Gustav Eisen sent from Fresno specimens of typical *skiltonianus skiltonianus* (which apparently does not occur in this locality at the present time), together with *gilberti rubricaudatus* and the type of the present form, I regard it as quite probable that there may be an error as regards the type locality of the present form, *skiltonianus brevipes*."

From the material that Eisen had collected at Fresno, Taylor recognized specimens that he felt reasonably sure could not have come from there, and the fact that many early collectors gave very general or incorrect locality designations to their specimens would seem to lend support to the idea that Eisen mislabeled his. However, more recent information on the geographic distribution and variation of the skinks, and a letter from Eisen, clarify the situation.

Taylor's assumption that the type, said to have been taken at Fresno, must have actually been taken in or near Eldorado County, was based on a similarity in color pattern between the type and his skinks from Eldorado County. However, our studies show that intermediates between *gilberti* and *rubricaudatus* may have the same feature of color pattern. Since such intermediates may be found along the floor of the San Joaquin Valley, only a few miles southeast of Fresno, it seems safe to assume that this accounts for the character of the type. Further evidence that the type of *brevipes* does not belong with the population of skinks in Eldorado County was furnished by Dr. Gustav Eisen, the collector, at the age of 91. In response to our inquiries regarding his early collecting, he stated, in a letter of June 5, 1939: "I do remember very well that I collected skinks in Fresno County and nowhere else.... I collected both around my brother's vineyard on the plains 12 miles from Centerville and Kings River, and 6 miles from Fresno. I also collected east of my brother's place up as far as headwaters of Kings and San Joaquin rivers.... I *never* collected *anything* of *any* kind in Eldorado Co." Dr. Eisen further explains, in his letter, that he always used great care in labeling his specimens accu-

rately, and that his collections (with the exception of earthworms) consisted of specimens taken by himself.

As for specimens of *rubricaudatus* or *skiltonianus* reportedly sent in from Fresno by Gustav Eisen, the "*rubricaudatus*" might well have been intermediates between *gilberti* and *rubricaudatus* (see p. 199) from a few miles southeast of Fresno or intermediates between *rubricaudatus* and *cancellosus* from southwestern Fresno County. The "*skiltonianus*" might easily have been young *gilberti* from the hills to the east of Fresno. Young *gilberti* are easily mistaken for *skiltonianus*.

Therefore, we think it is clear that the name *brevipes* should remain a synonym of *gilberti*.

The population referred to as *E. skiltonianus brevipes*, thus left without a name, has since been described (Rodgers, 1944) as *E. gilberti placerensis*.

The populations in the desert mountain ranges formerly considered to be *E. g. gilberti* now prove to be indistinguishable from *rubricaudatus*.

At the northern end of the range of the species *gilberti* in the inner Coast Ranges, from the junction of the San Joaquin and Sacramento rivers south to Pacheco Pass in western Merced County, the population differs markedly from other populations of *gilberti* and is recognized by us as a new subspecies, *Eumeces gilberti cancellosus*.

The small skink of southern Lower California, named as *E. lagunensis*, we consider as a distinct species, closely related to *skiltonianus*.

The following forms are recognized in this study:

Eumeces gilberti gilberti Van Denburgh
Eumeces gilberti cancellosus subsp. nov.
Eumeces gilberti placerensis Rodgers
Eumeces gilberti rubricaudatus Taylor
Eumeces lagunensis Van Denburgh
Eumeces skiltonianus Baird and Girard

METHODS

Collecting.—It was found that, as a rule, skinks can be effectively collected only during a small part of the year, in March, April, and May. At this season they are active on the surface of the ground, and they commonly can be found beneath rocks. In the desert mountains in 1938 they were as easily obtainable in June as in May, and they were not found under rocks, but were shot while foraging under bushes. Later in the season, when the soil has dried out, skinks are more difficult to locate. It is generally supposed that they then suspend activity and remain below ground; however, it is possible that they remain active. They may be hard to find because much more cover in the form of vegetation and cracks in the ground is available to them. There is no noticeable resumption of activity in cooler weather in the fall, and it is of course impracticable to collect them in the winter, when activity is suspended.

Collecting has been greatly facilitated by the extensive network of roads in California, which makes it possible to inspect many remote places in a short time. Unlike many vertebrate species, skinks do not necessarily retreat

before human occupation of the land; in fact, through some kinds of man-made changes they may become more numerous.

To obtain needed series the collector drove through a region and carefully selected stopping places where optimal conditions of habitat seemed to prevail. Gently sloping hillsides strewn with rocks were apt to repay investigation. Old woodpiles, boards about deserted ranch buildings, and fallen fences were likely to yield specimens; they often provided the only easily movable objects for skinks to take refuge under. Even at localities of promising aspect, only an hour or so was spent in search if no specimens were obtained. Thus it was possible to sample many localities over a wide area in the course of a day's collecting. Specimens usually were subjected to at least cursory examination soon after being taken, and the trends indicated by them were immediately used to guide the course of subsequent exploration.

Laboratory.—Most of the specimens were brought to the laboratory alive and were uniformly subjected to killing and preserving technique. Selected specimens were used, before killing, for careful recording of the natural colors as determined from Ridgway's color key. Some of the lizards were kept in captivity. Young did not live for more than a few months, but adults survived for several years. Growth data for size and weight as well as some records of seasonal color changes were thus obtained.

Selection of comparable material.—In the selection of material to show age, sexual, and finally geographic differences, an unusual amount of caution was exercised. This may have been carried to an unnecessary extreme, but it was done in order thoroughly to familiarize the authors with the complicated trends of variation as early in the progress of the study as possible. We wished particularly to avoid a common pitfall in making geographic comparison in the West—that of overlooking the importance of distances of but a few miles in a highly diverse terrain.

It was demonstrated for *skiltonianus* that size can be taken as a safe criterion of age among individuals up to two or three years of age (Rodgers and Memmler, 1943). Size, therefore, has been assumed to indicate age in all forms, but age determinations on this basis have been substantiated and at times modified by examination of gonads. A group of small individuals with undeveloped gonads could easily be separated from the others; these are referred to as "young." They are probably all under 15 months of age. A group of large individuals, with enlarged gonads or developing eggs, were classed as "breeding adults"; probably all are three or more years old. All the remaining individuals of the series were grouped under the heading of "subadults." It was soon discovered that some individuals with swollen gonads or developing eggs were much smaller than many so-called subadults, and that some very large individuals did not have swollen gonads or developing eggs. Some very large specimens that were collected in the late summer, fall, and winter were included with breeding adults if their gonads seemed to have regressed. As a result, except where definitely breeding adults were desired for comparison, the "subadults" and "breeding adults" were combined and referred to simply as "adults." Thus, in most comparisons, specimens referred to as "young"

include only young individuals, but those referred to as "adult" may include a few individuals which have not yet reached breeding age.

Comparisons of age and sex groups were first made within our largest series from single localities. Information so gained was then used in studying age and sex differences in smaller series. Geographic comparisons were first made between samples from many small areas. Subsequently, data on specimens from different areas were combined, when combination was justified. Each character required separate treatment, for it was found that geographic trends in one character do not necessarily parallel those in another. Finally, material was grouped on the basis of the most salient characters, this being the most useful basis for nomenclatural recognition of forms.

Selection of characters.—Many characters that have commonly been used in descriptions of forms of skinks are eliminated even from mention here because investigation has shown geographic variation to be very slight, or because great individual variation obscures any geographic trends in the limited series available.

GENERAL DISTRIBUTION AND HABITAT

The combined ranges of *E. skiltonianus, E. gilberti,* and *E. lagunensis* cover most of the area west of the Rocky Mountains. The most wide-ranging species, *skiltonianus,* has been found in British Columbia, Washington, Oregon, Idaho, western Montana, California, Nevada, western Utah, and northern Lower California. The least wide-ranging species, *lagunensis,* is restricted to the southern third of Lower California. The species *gilberti* is restricted almost entirely to California. It has been found in the Sierra Nevada, some parts of the Sacramento and San Joaquin valleys, the inner Coast Ranges west of the San Joaquin Valley, the Tehachapi Mountains, southwestern California west of the deserts, the mountains of the northern and southern Mohave Desert, and extreme western Nevada east of Death Valley. It also occurs in extreme northern Lower California and in southern Yavapai County in west-central Arizona. There are four races of this species. Two of them are restricted to the western side of the Sierra Nevada, below 6,500 feet. One, *E. g. placerensis,* occurs south of the Yuba River and north of Tuolumne County and also extends onto the valley floor in San Joaquin County. The other, *E. g. gilberti,* occurs from Tuolumne County south into northern Tulare County. The third race, *E. g. cancellosus,* has been found only in the inner Coast Ranges, from the junction of the San Joaquin and Sacramento rivers south to Pacheco Pass in western Merced County. The fourth, *E. g. rubricaudatus,* occupies the remaining portion of the range of the species and hence is the most widespread race. Intermediates are found between the ranges of all forms of *E. gilberti* whose ranges adjoin and also between *E. g. gilberti* and *cancellosus.*

In the Great Basin, *skiltonianus* is spotty in occurrence and is restricted to the cooler, higher areas of certain mountain ranges. In California the range of *skiltonianus* is nearly continuous. The species attains its maximum abundance in the Transition Life-zone, but is also common in the Upper Sonoran and occurs in some of the lower parts of the Canadian Life-zone. Although it

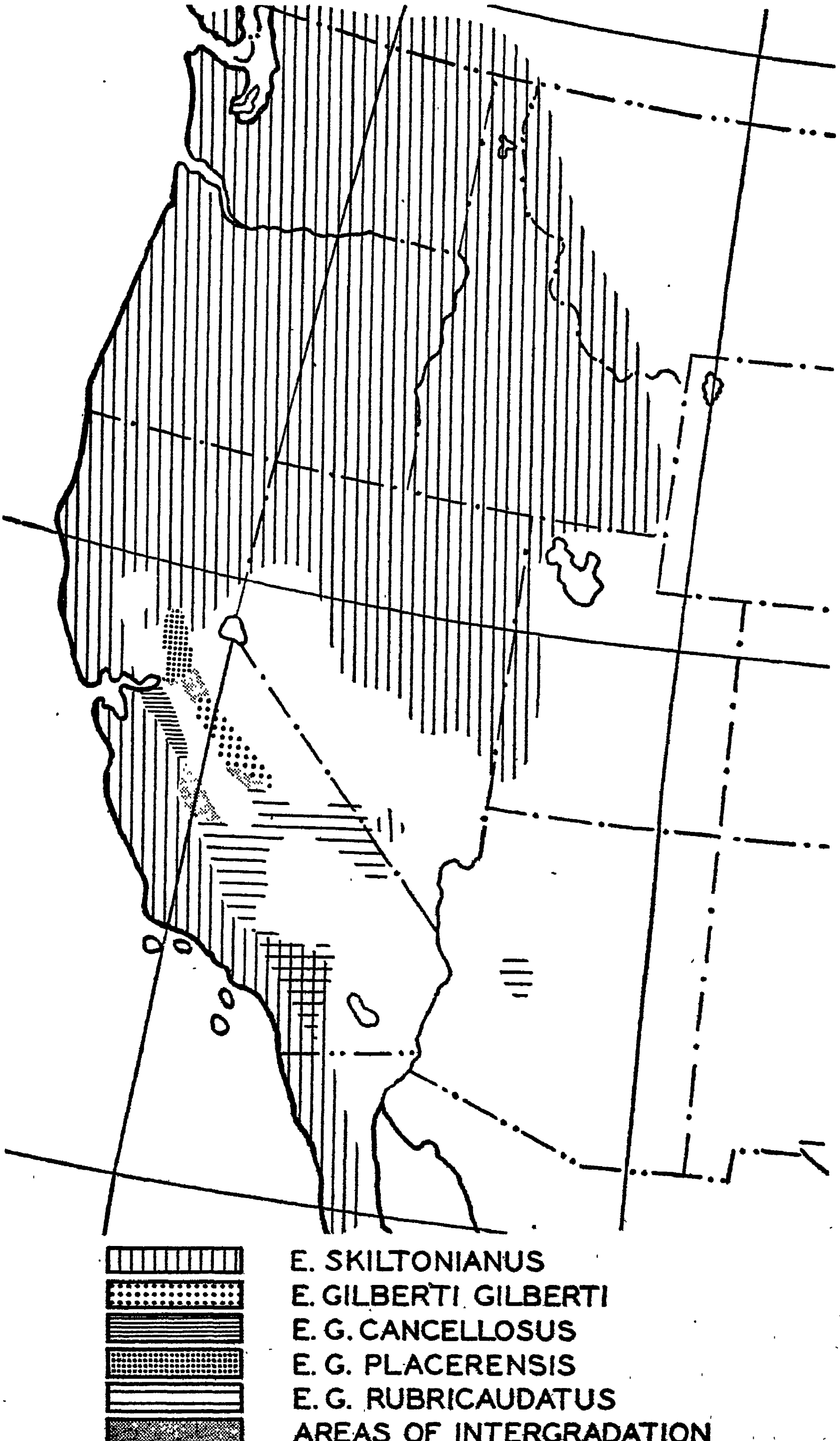


Fig. 1. Map showing distribution of the species and races of the *skiltonianus* group of skinks. *E. lagunensis,* not shown, is known only from the cape region of Lower California.

seems to be adaptable to widely different habitats and climates, it appears to favor moderately humid climate. It is apt to be concentrated in localized colonies where there is an abundance of ground cover in the form of dead wood or flat rocks and a good growth of herbaceous vegetation. If the latter is dense and well supplied with rodent runways, it may support many skinks. The localities where *skiltonianus* has been found in greatest abundance are mostly in or near open woods of blue oak, garry oak, or coast live oak and bay (*Umbellularia*). The food consists largely of ground-living insects which subsist on the herbaceous plant cover. In places where the ground is relatively barren of herbaceous plants, as in incense cedar–black oak woods, these skinks are usually rare or absent.

E. g. cancellosus seems to be restricted to rock outcrops on grassy hills, where there are no trees or shrubs. It appears to be limited on the south by the Pacheco Pass region, where there is much less moisture than to the northward.

E. g. gilberti and *E. g. placerensis* are found mainly in the Upper Sonoran and Transition life-zones. Although in general they are much like *skiltonianus* in their habitat preference, they prefer situations of lower life-zone. They are characteristically a form of the blue oak belt in the foothills of the Sacramento–San Joaquin Valley, although both races have been found on the valley floor in San Joaquin and Stanislaus counties far from the blue oak belt. Like *skiltonianus,* they are partial to rocky situations and depend largely on rocks for shelter. Specimens of *gilberti* in captivity have been noted to burrow in light loam and to use the burrows thus made for future retreat. In the northern Sierra Nevada, there seems to be no difference in the habitats occupied by the two species, yet their ranges apparently do not overlap. It is difficult to see why *E. g. placerensis* does not extend its range across the Yuba River into the range of *skiltonianus,* or why *skiltonianus,* occurring south of the Yuba River at 4,000 feet elevation, does not extend its range into that of *placerensis,* at 2,500 feet.

In the southern Sierra Nevada, in the Tehachapi Mountains, and in the inner Coast Ranges west of the San Joaquin Valley, *rubricaudatus* occupies situations much the same as those where *gilberti* occurs farther north. In southwestern California, *rubricaudatus* occurs in country where there is scattered brush and much rock cover as well as in oak woodland. It has been found with *skiltonianus* here, but generally it occurs at lower elevations and in drier situations. In the desert mountains, it is found in some of the broad valleys the floors of which are covered with scattered brush and where there is no place to seek refuge except in rodent burrows and in the debris at the bases of the bushes. It has also been found near the bases of rocky hillsides and under fallen Joshua trees associated with *Xantusia vigilis.*

IDENTIFICATION OF THE FORMS OF SKINKS OF THE SKILTONIANUS GROUP

The complicated color metamorphoses and the great amount of geographic variation within the various forms prevent construction of a simple workable key to all the forms. The age of many specimens cannot be determined unless

the racial identity is known first; hence the necessity for a key that will be applicable to specimens of any age. However, the problem is somewhat simplified by the fact that the ranges of the various forms overlap in only a few places. Most specimens can therefore be identified on the basis of range, and the identification can be confirmed by a check of the diagnosis of the form. Where the ranges of the forms overlap or are so closely associated that the animals might be confused, specimens can be identified by the following key:

I. Specimens from the Sierra Nevada, in the drainage of the Yuba and American rivers .... A.

II. Specimens from eastern Contra Costa, Alameda, and Santa Clara counties or extreme western San Joaquin, Stanislaus, and Merced counties .... B.

III. Specimens from San Benito County, eastern Monterey, or San Luis Obispo counties .... B.

IV. Specimens from Ventura, Los Angeles, southwestern San Bernardino, Orange, western Riverside, or San Diego counties .... D.

A. Snout–vent length greater than 75 mm., *or* with individual scales of light dorsolateral lines sharply outlined with brown or gray (pl. 8, *b*) ...... *Eumeces gilberti placerensis.*

AA. Snout–vent length not more than 76 mm., *and* individual scales of light dorsolateral lines usually not sharply outlined (if outlined, only weakly so) (pl. 8, *a*) *Eumeces skiltonianus.*

B. Snout–vent length greater than 84 mm., or interparietal nearly parallel-sided (fig. 5) and dark pigmentation on middorsal scale rows forming a double row of transverse bars, one on posterior edge of each scale (pl. 8, *d*); tail of juveniles may be pink or pink with light blue wash dorsally, but never bright blue.

C. Fitting these key characters, but from area in II (above) *Eumeces gilberti cancellosus.*

CC. Fitting these key characters, but from area in III (above) Intermediates between *Eumeces gilberti cancellosus* and *Eumeces gilberti rubricaudatus.*

BB. Snout–vent length not more than 84 mm.; interparietal bluntly wedge-shaped (fig. 5); dark pigmentation on two middorsal scale rows not as above (pl. 8, *a*); juveniles, and usually adults, with blue tail .... *Eumeces skiltonianus.*

D. Snout–vent length greater than 75 mm.; or interparietal nearly parallel-sided; specimens under 50 mm. snout–vent length with pink tail (no blue); 8 supralabials on each side (98 per cent); color pattern, when present, much like that of *cancellosus* *Eumeces gilberti rubricaudatus.*

DD. Snout–vent length not more than 75 mm., interparietal bluntly wedge-shaped; juveniles, usually adults, with blue tail; 7 supralabials on one or both sides in frequency of 94 per cent (7 on each side, 80 per cent) .... *Eumeces skiltonianus.*

INDIVIDUAL, SEXUAL, AND AGE VARIATION

Individual variation.—An individual of any given age and sex is relatively bright-colored immediately after shedding its skin, and it darkens and becomes duller as the next molt approaches. If the individual is an adult and is approaching the breeding season, the shedding of the skin may leave it especially bright, but if it has passed the peak of its sexual activity, shedding may leave it comparatively dull. The change at time of shedding may be through several shades of color.

The change of color as a result of shedding is illustrated by the following records of a group of captive individuals of *E. g. gilberti* from 18 miles north-

east of Fresno, California (these individuals had not yet reached breeding age and therefore did not exhibit seasonal breeding coloration):

April 9, head and most of back dark brown (ranging on different individuals from Prout's Brown, Plate XV, 15'*m*, of Ridgway, to Mummy Brown, Plate XV, 17'*m*); posterior part of back lighter brown (near Dresden Brown, Plate XV, 17'*i*, on all individuals).

April 12, after shedding, head reddish brown (ranging from Amber Brown, Plate III, 13*k*, to Olive Brown, Plate XL, 17'''*k*); back dull green (ranging from Andover Green, Plate XLVII, 25''''*i*, to Sage Green, Plate XLVII, 29'''').

The change in color at time of shedding of a male approaching the breeding season is illustrated by the following notes on a large captive *E. g. gilberti* from Madera County, California:

April 25, before shedding, head somewhat reddish and back and tail yellowish olive-green. The season during which the coloration, especially of the head, of breeding males is brightest was approaching. Color records follow: Head, Cinnamon-Rufous (Plate XIV, 11'*i*) dorsally, between Cinnamon-Rufous and Apricot Orange (Plate XIV, 11') dorsolaterally; lateral temporal region near Apricot Orange, but toward Apricot Buff (Plate XIV, 11'*b*); region of labials and ear nearer Apricot Buff than Apricot Orange, fading ventrally to near Salmon-Buff (Plate XIV, 11'*d*) with a light mottling of a color between Salmon-Buff and Apricot Buff extending over the ventral surface. Dorsally, scattered faint spots of a color between Apricot Orange and Cinnamon-Rufous extend back onto the shoulder region. Back, between Saccardo's Olive and Olive-Citrine (Plate XVI, 20'*m*), but slightly darker; tail Olive-Citrine.

May 20, after shedding, head and neck bright reddish brown and back and tail changed to a more bluish green. Color records follow: Head, between Burnt Sienna and Chestnut (Plate II, 9*l*) dorsally, slightly lighter laterally, labials near Mars Orange (Plate II, 9*h*); throat, back nearly to front legs, near Bittersweet Orange (Plate II, 8*c*). Dorsally, the bright head color extends back on the neck and shoulders as a mottling. Back, between Andover Green (Plate XLVII, 25'''*i*) and Sage Green (Plate XLVII, 29'''), but slightly brighter and with a light wash of Olive-Citrine (Plate XVI, 21'*m*); tail same as back, but without wash of Olive-Citrine.

In characters of size and scalation it is possible accurately to determine the individual and group variations only when the series of specimens analyzed are large enough to be treated statistically. However, even without statistical proof, repeated occurrence of similar differences in small samples and orderly geographic trends furnish convincing evidence of variation. Where groups compared are large enough for statistical treatment, statistical indices are presented that will give an idea of the amount and character of the variation and will prove or disprove the validity of differences.

Sexual variation.—Comparing specimens that have been sexed by examination of the gonads, we found that sexual dimorphism does occur and that it is not the same in all forms. Since sexual dimorphism has definite geographic significance, its discussion here is usually combined with that of geographic variation. Sexual variation of a seasonal nature is exhibited by breeding males (see p. 179). It is probably also exhibited to a lesser degree by breeding females.

Age variation.—Comparison of specimens of different sizes and with gonads of various sizes and apparent degrees of activity establishes the fact that there is age variation in characters such as size, proportion, and coloration (see section on methods, pp. 172–174).

COLOR

The analysis of color is complicated by the existence of a variety of elements that may vary independently. The quantity of a certain pigment produced or showing at the surface of the skin may have great effect on the appearance of the pattern. The relation of the rate of development, and consequent reduction, of the pattern to the rate of growth of the animal is significant and variable. There may be differences in the distribution of the centers of development of pigment, resulting in different arrangements of the parts of a pattern. Different parts of the color pattern, such as the ground color, the dark pigment superimposed on the ground color, the pigmentation of the light longitudinal lines, the tail color, or the bright red or orange coloration taken on during the breeding season, may vary independently of each other. However, there is little, if any, variation of the color of an individual in response to changes in temperature, light, or humidity.

Variation in degree of loss of color pattern of back and sides.—The color pattern of a skink develops from the dark, sharply defined, striped pattern that is common to all young, to one of the many adult patterns. Pattern is conveniently described as passing through a series of different stages which of course actually represent arbitrary points in a gradually changing pattern. The rate of development in relation to growth in size differs in the several forms: *skiltonianus,* which is the smallest, retains its striped pattern throughout life and *E. g. gilberti,* which is the largest, loses all traces of this pattern early in life. It has been assumed (Camp, 1916) that *gilberti* simply develops further in this respect than *skiltonianus*; this implies that if *skiltonianus* were to develop further, it would become like *gilberti.* That *skiltonianus* is not merely a retarded form of *gilberti* is proved by the demonstration of differences in scale characters, which, of course, do not vary with age, and by the fact that *gilberti* loses its color pattern before it reaches the maximum size of *skiltonianus.*

The extreme retention of color pattern is represented by *skiltonianus,* in which it may also be noted that there is no sexual difference in retention. The opposite extreme is represented by *E. g. gilberti,* the color pattern being lost by some individuals that are less than 60 mm. long. Some females of *E. g. gilberti* retain a wash of dark pigmentation on the sides until they have reached 90 mm.—nearly maximum size for the females of this race. The races retaining the most color pattern have the least sexual difference in this character.

Variation in form of color pattern of back and sides.—The pattern of the back and sides consists of three main elements: a ground color, the dorsolateral and lateral light lines, and a dark brown or black pigment that is superimposed on the ground color. Reference to plate 8 will aid in understanding the color-pattern phenomena described in the following pages.

The ground color may be brown, olive brown, grayish brown, bluish gray, or greenish gray. It is almost entirely obscured by dark pigment in the young; it serves as a background for the pattern of light longitudinal lines and dark pigment in larger young and adults of some forms, and constitutes the uniform

patternless coloration of adults that have lost the light lines and dark pigmentation. There is probably significant geographic variation in ground color, but it is obscured by changes during the molting cycle in newly taken specimens, and by the discoloring action of preservatives upon specimens in museum collections. The only positive statement that can be made here is that the ground color of *cancellosus* and *rubricaudatus* is more tannish and less greenish than that of *gilberti* and *placerensis*.

The dorsolateral light-colored lines lie along the outer one-fourth to three-fourths of the second scale rows and the inner one-fourth to three-fourths of the third scale rows and extend from the rostral scales through the supraoculars and along the back to the tail, where they fade out one-tenth to one-third of the way along the tail. The lateral lines, usually narrower and less sharply defined than the dorsolateral lines, usually lie in the sixth scale row but may overlap the lower edge of the fifth or the upper edge of the seventh rows. They extend from the rostral scale along the supralabials, across the ear opening, along the side just over the front leg and just over (or are broken by) the hind leg; they fade out on the side of the tail near the base.

The lateral lines are of little use in systematics because of their extreme variability and indefiniteness, and they therefore are not given further consideration here.

The position of the dorsolateral lines varies greatly on individuals, but we think that careful measurement of large series of specimens would show a tendency for these lines to lie closer to the median line in the races *cancellosus* and *rubricaudatus* of the species *gilberti* and farther from the median line in the other two races of *gilberti* and in *skiltonianus*. Because of the great individual variation and the lack of enough young specimens of all forms, this character is not given further attention. A more thorough comparison of larger numbers of specimens of comparable groups might show that those forms having the dorsolateral lines nearest the middorsal line also have the widest dorsolateral lines.

The color of the dorsolateral lines varies according to the stage of molt, and it is our impression that there are also some geographically significant differences in color; it is impossible, however, to learn a great deal about this from preserved material.

The most useful characteristic of the dorsolateral lines arises from the fact that the light scales are often bordered or edged with brown. This condition is found in many parts of the range of *skiltonianus* in varying frequency and definiteness, but nowhere as frequently or as well developed as in *placerensis*. Fortunately for those who try to identify skinks in the northern Sierra Nevada, the brown edging is almost entirely absent from *skiltonianus* in that area. Thus, with comparative material, one can identify immature specimens by this character alone. The edging of the scales is, however, not well developen until the animals are 6 or 8 months old. The brown edging is also characteristic of immature *gilberti*.

The amount of dark pigment superimposed on the ground color changes greatly during the life of an individual and differs also in the various forms.

On the sides, the dark brown or black pigment completely obscures the lighter ground color in young. As the individual grows, this dark pigment gradually breaks up so that the ground color shows through on every scale. The result may be an irregular mottling of dark and light colors or more or less definite bars, one light and one dark, on each scale. Definiteness of the bars, or lack of it, seems to have no relation to geographic distribution. There is a tendency throughout the forms for a stronger break-through of the ground color in the inner edge of the fourth scale row which isolates the dark pigment in the outer edge of the third scale row as a continuous dark line or a row of dots bordering the outer edge of the dorsolateral line. The dark color persists longer on the sides than in any other part of the color pattern, and as a result, in some forms, adult specimens have no color pattern except a dark wash on the sides.

In the area between the dorsolateral light lines, the dark pigment rarely if ever completely obscures the ground color, even in the youngest and darkest specimens. In the youngest specimens of all forms there is a heavy line of dark pigment along the inner margins of the dorsolateral lines. In *skiltonianus* there is usually also a scattering of black melanophores, singly and in groups, over the ground color of the back. In the species *gilberti* the black pigment that extends mediad from the inner border of the dorsolateral lines more commonly tends to be confined to either the anterior or posterior part of each scale of the first scale rows, forming a series of more or less sharply defined transverse bars, and usually there is a narrow vertebral area where the ground color is not obscured by dark pigment. In *E. g. placerensis* and *E. g. gilberti* such bars on the scales of the first rows persist for only a short time, and when they fade out, the dark lines along the inner edge of the dorsolateral lines usually fade out too, but much earlier in *gilberti* than in *placerensis*. In *E. g. rubricaudatus* and *E. g. cancellosus* the reduction of dark pigment between the bars makes them stand out more sharply, and further reduction of dark pigment in these two forms usually results in a double row of bars on the scales of the first scale rows; this row connects with a row of dots or shorter bars along the inner margin of each of the dorsolateral lines. The barring thus formed fades out, along with the dots along the dorsolateral lines, in all adult males and most adult females of *rubricaudatus,* but only in adult males in *cancellosus.*

In *rubricaudatus* and *cancellosus* the bars consist of dark brown or black pigment retained on the posterior edges of the middorsal scales. In *placerensis, gilberti,* and *skiltonianus,* normal pattern including these bars is rare and, when present, is irregular; the bars are usually not sharply defined and often are incomplete or broken. In specimens not having this pattern naturally, a similar effect has been produced by discoloration in preservative, which darkens that portion of the scale in closest contact with the body and leaves a lighter posterior margin. This was noted in about 5 per cent of all specimens examined regardless of species or subspecies.

When the dark pigment in the middorsal area has been reduced to a narrow line or row of spots bordering the inner edge of each dorsolateral line, the line or spots usually lie on the second scale row at the point where the posterior

margin of the scales is met by the posterior margin of the adjacent scales in the first scale row. This is typical of *skiltonianus, placerensis,* and *gilberti,* and in these forms this spot of dark pigment only rarely extends to the inner corner of the scale. In *cancellosus* and *rubricaudatus* reduction of the dark pigment of the middorsal area to a spot on the inner edge of the dorsolateral line is uncommon. When reduction does occur, the spot nearly always extends to the inner corner of the scale and usually forms a border or a bar, along the free edge of the scale, rather than a spot. Also, in many *skiltonianus, placerensis,* and *gilberti* the spot of dark pigment on the inner part of each scale of the second scale row is in contact with a spot of pigment in the outer corner of the *adjacent* scale of the first row. This often forms an irregularly shaped spot which spans the two scales. In *cancellosus* and *rubricaudatus* the dark pigment on the inner part of each scale of the second scale row is usually in contact with a bar of dark pigment along the free edge of each scale in the first scale row, *but* in the scale just *anterior to the adjacent one.* This forms a bent bar-shaped mark. There is considerable individual and age variation in the shape of these spots and bars, but well-formed bars on the scales of the first scale row are rare in *skiltonianus, placerensis,* and *gilberti.*

The different ways in which spots or bars on the two scale rows combine may be due to the varying position of the dark pigment in relation to the middorsal line. Each mark of dark pigment appears to be confined to the scale on which it is found. That is, if the mark appears nearer to or farther from the middorsal line, it also appears correspondingly farther forward or aft as a result of its following the slope of the edge of the scale. Thus, a wider lateral displacement of the dark pigment spots would bring about the pattern described above as typical for *skiltonianus, placerensis,* and *gilberti,* and less wide lateral displacement would serve to explain the pattern described for *rubricaudatus* and *cancellosus.*

When these two types of patterns meet in crosses between the different forms, the factors controlling this phase of the color pattern appear to be segregated and to interact so as to produce a color pattern unlike any known in the *skiltonianus* group. Examples of this "hybrid" form of color pattern were figured by Taylor (1935, plate 38, figs. 2, 4) and one is figured here (fig. 2). Others have been found along the eastern side of the San Joaquin Valley, where *gilberti* has crossed with a *cancellosus*- or *rubricaudatus*-like form. Collections from two of these populations (west of Madera and at Smith Ranch) contain specimens resembling *gilberti* and others resembling *cancellosus* or *rubricaudatus* as well as individuals bearing the "hybrid" pattern. Intergradation between *gilberti* and *rubricaudatus* in northern Tulare County (see map, fig. 6) appears to be smoother, but is complicated by extra dark pigmentation which seems to be typical in the area (other reptiles are also darker in this area).

Tail color.—One of the most conspicuous characters of the skinks of this group is the color of the tail, especially of juveniles. On the basis of tail color of juveniles alone, the forms can be divided into two distinct groups, the pink-tailed *cancellosus* and *rubricaudatus* and the bright-blue-tailed *skiltonianus,*

placerensis, and *gilberti. Eumeces lagunensis* is said to have a salmon-colored tail with some grayish heliotrope dorsally, but since little is known about it, *lagunensis* is not mentioned further in this discussoin.

In northern California, as far south in the Sierra Nevada as Tulare County and south along the coast (except the innermost ranges south of Carquinez Straits) to Ventura County, only blue-tailed juvenal skinks have been found. In the hills along the west side of the San Joaquin Valley south of Carquinez Straits, and around the head of that valley as far north on the eastern side as southern Fresno County, only pink-tailed skinks have been found. In the foothills of the principal mountain ranges of southwestern California and in

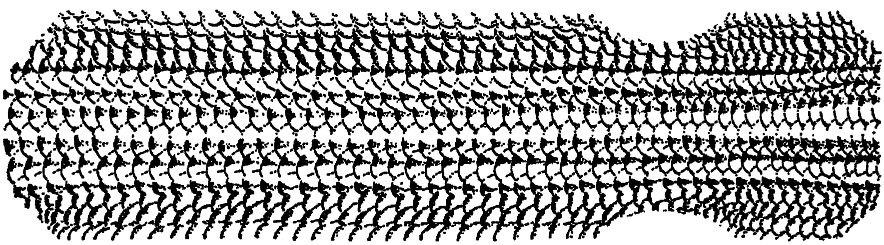


Fig. 2. Sketch of pattern on back and sides of specimen from floor of San Joaquin Valley, 7 miles east-southeast of Stockton, San Joaquin County (Mus. Vert. Zoöl. no. 37214), showing unusual distribution of dark pigment in middorsal area, probably resulting from crossing of *placerensis*-like and *cancellosus*-like parents.

many other parts of Los Angeles, Riverside, and San Diego counties, both the pink-tailed and the blue-tailed juveniles have been found, representing there the two species of the group.

The color of the pink tails is between Grenadine and Bittersweet Pink (Ridgway, Plate II, 8*c*) dorsally and is lighter laterally and ventrally. The color of the blue tail of an individual from Santa Clara County (typical *skiltonianus*) was recorded as between Ultramarine Ash and Dull Violaceous Blue (Plate XXII, 50) dorsally, Forget-me-not Blue (Plate XXII, 51*b*) laterally, and light Forget-me-not Blue (Plate XXII, 51*d*) ventrally. The dorsal color of the tail of one young individual from southern Madera County (*E. g. gilberti*) was between Diva Blue and Sailor Blue (Plate XXI, 42′*j*) and the dorsal color of three others was nearer Diva Blue than Commelina Blue (between Plate XXI, 51′*h* and Diva Blue). There is often some pink on the ventral surface of blue tails that may be Apricot Orange (Plate XIV, 11′) or Apricot Buff (Pl. XIV, 11′*b*), or some intermediate color.

In southern Inyo and northern San Bernardino counties, California, in extreme southwestern Nye County, Nevada, and Yavapai County, Arizona, where *E. g. rubricaudatus* has been collected, no young skinks have yet been obtained, but judging from the character of the adults, the skinks of this area probably have pink tails when young.

In the northern part of the range of the pink-tailed group, from Carquinez Straits to San Benito County in the hills just west of the San Joaquin Valley and in southern Fresno and northern Tulare counties in the lowest foothills

just east of the San Joaquin Valley, the pink-tailed young have a wash of blue on the dorsal surface of the tail.

In the skinks having pink tails when young, the color fades and is lost at an early age, before a snout–vent length of 60 mm. is attained, and the tail becomes about the same color as the body.

The skinks having blue tails can be divided into two main groups: those from the Sierra Nevada, and those from the rest of the range described for blue-tailed skinks (p. 183). Those from the central Sierra Nevada (Tuolumne to Tulare counties) lose the blue early in life, by the time they have reached a snout–vent length of 60 mm. This is the race *E. g. gilberti.* Those from the northern Sierra Nevada (*E. g. placerensis*) retain the blue longer; some from the San Joaquin Valley, where the range extends out onto the floor of the valley, still have bluish gray tails after attaining a length of 75 mm. Many individuals from the rest of the range of the blue-tailed skinks retain the blue throughout life.

The blue tail of *E. g. gilberti* may fade out, leaving the tail the same color as the back, sides, and legs, or it may become red. It may vary from Dragon's-Blood Red (Pl. XIII, 5′*i*) dorsally and Rufous (Pl. XIV, 9′) ventrally, to between Jasper Pink and Chatenay Pink (Pl. XIII, 3′*e*) dorsally and Chatenay Pink ventrally. Either original or regenerated tails may be red. In the southern part of the range, some individuals have been found with purple tails. One individual from 2 miles northeast of Academy, Fresno County, had a tail that was Grayish Violaceous Blue (Pl. XXII, 51*i*) dorsally, light Wisteria Violet (Pl. XXIII, 59′*d*) low on the sides, and near Peach Red (Pl. I, 5*b*) ventrally. Another individual, collected at the same time and place, had a mottling of Dull Violaceous Blue (Pl. XXII, 51) (slightly lighter than the typical blue of blue-tailed young) over a color nearly like Peach Red (Pl. I, 5*b*), giving the distal one-third of the tail a purplish appearance, but most of the area really was a mosaic of blue and red. After being in captivity for two years and eight months, this individual was described as having a bright red tail with one bright purplish blue scale on the dorsal surface. Nearly all the blue had been replaced or obscured by red.

Head color.—The skinks that retain the dorsal color pattern and blue tail (*skiltonianus*) never have completely red heads. Those that lose the bright blue juvenal tail color and the striped dorsal color pattern (many *E. g. placerensis* and all *E. g. gilberti*) often have bright red heads when adult, as is true of those that have pink tails when young (*cancellosus* and *rubricaudatus*), at least in parts of their range. This redness is known to vary seasonally (see p. 178).

The red labials of one brightly colored individual of *skiltonianus* were between Bittersweet Pink and Bittersweet Orange (Pl. II, 9*c*).

An adult male of *cancellosus* collected at Arroyo Cavelano, 1,150 feet, Contra Costa County, May 19, 1938, was described as follows: top of head between Burnt Sienna and Mars Orange (Pl. II, 9*j*), temporal region slightly lighter; lower labials between Flame Scarlet and Pl. II, 8*h*; sides of throat between Bittersweet Orange and Pl. II, 8c. This differs from the red of *E. g.*

gilberti only in its slightly paler shade. The males of skinks (*rubricaudatus*) collected in the Providence Mountains, May 26, 1938, were described in field notes as "orange." A typical red-headed adult *E. g. gilberti,* before and after shedding, was described on p. 178.

Although some females of *gilberti* have extensive bright red coloring on their heads, it does not extend back on the neck and shoulders as in some males. Of five adults from Madera County and northern Fresno County, two of the males had red heads and green tails and another had no red on the head but had a red tail. Two females had red heads and red tails. Other adult females from Madera County had no red on head or tail. Two adult males and two adult females from Fresno and Tulare counties all had red heads and red tails. Head color and tail color thus do not seem to be closely correlated.

SIZE, RELATIVE LIMB LENGTH, AND SCALATION

In comparisons of *skiltonianus* with the four races of *gilberti* in the following tables and graphs, the data on *skiltonianus* and *rubricaudatus* are based solely on specimens from California unless otherwise stated. Data on *placerensis, gilberti,* and *cancellosus* are from all available specimens of those forms, whose ranges lie entirely within the boundaries of California.

Snout–vent length.—This measurement is the distance from the most anterior point on the rostral scale to the posterior edge of the large scales (often referred to as preanals) that lie just anterior to the vent and usually cover its opening. Data used in comparison of the five forms in California are from the specimens that were classed as "breeding adult" or as "subadult" (see p. 173).

E. skiltonianus stands out as being conspicuously shorter than any race of *gilberti,* and *E. g. gilberti* is the only form in which there is a noticeable sexual difference in length (fig. 3, *a*).

Relative length of legs.—Leg length was taken from the tip of the longest toe (excluding the claw) to the angle with the body (posterior to front leg and anterior to hind leg), with the leg extended at right angles to the body. Measurements were always made on the left leg unless it was damaged, in which event the right leg was used. Relative leg length is given in relation to snout–vent length.

Comparison of young with adults in the species *skiltonianus* shows that there is very little, if any, difference between relative leg length of young and adult males, but that, in females, legs are relatively longer in young than in adults. Development of longer trunk length in adult females, as a secondary sex character, may take place.

In *skiltonianus, gilberti,* and *rubricaudatus* (figure 3, *b* and *c*) both hind and front legs are shorter in females than in males. There is little, if any, such difference in *cancellosus* and *placerensis.*

In this character, *skiltonianus* resembles *E. g. rubricaudatus* more than it does either of the other three races of the species *gilberti.*

Scales from occiput to base of tail.—This scale count is made on one of the two medium rows, starting with the first nuchal and ending with the scale

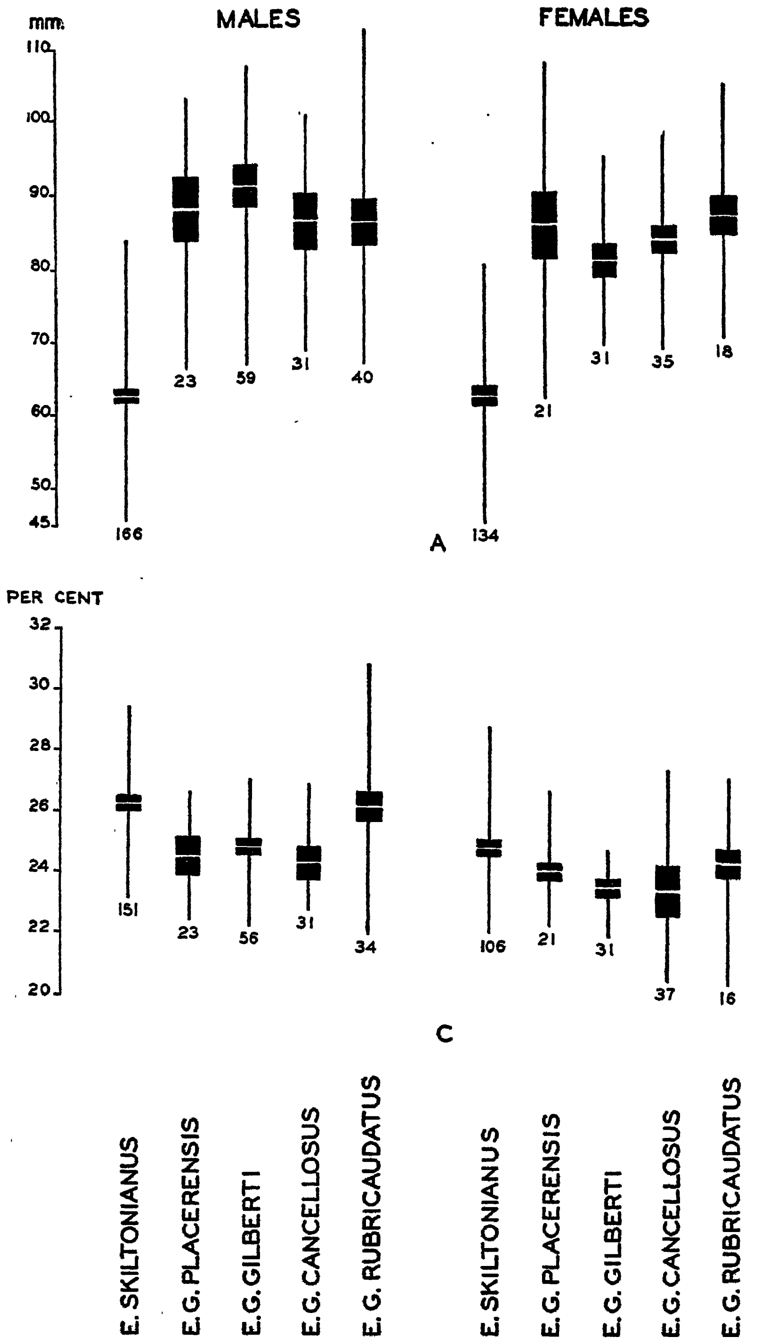
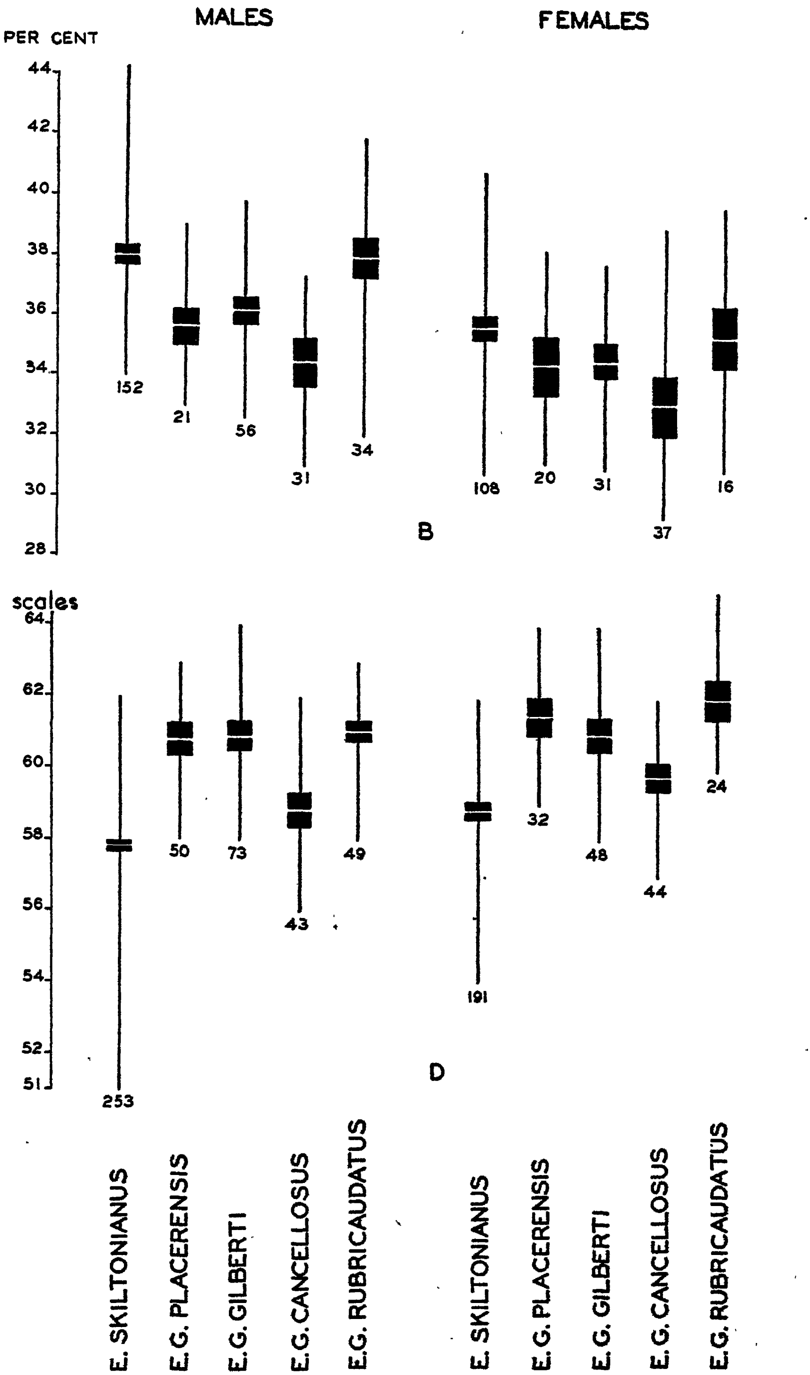


Fig. 3. Graphs for four different characters, comparing the ranges and means of data from large groups of specimens of *E. skiltonianus*, *E. g. placerensis*, *E. g. gilberti*, *E. g. cancellosus*, and *E. g. rubricaudatus*. Graphs constructed on plan of Dice and Laraas (1936). Vertical lines represent ranges; heavy white crossbars mark the means; dark rectangles extend a distance of two times the standard error of the mean above and below mean. If



rectangle for one set of data does not overlap rectangle for another, difference between means is statistically significant. Number at base of each vertical line is number of individuals in group of specimens. (*a*) Snout–vent length; (*b*) ratio of length of hind leg to snout–vent length; (*c*) ratio of length of foreleg to snout–vent length; (*d*) number of scales from occiput to base of tail.

TABLE 1

SNOUT–VENT LENGTH
(In millimeters)

Species or subspecies	Males				Females			
	No. of specimens	Mean (min.–max.)	σ	v	No. of specimens	Mean (min.–max.)	σ	v
E. skiltonianus	166	62.7±.42 (45.6–82.9)	5.35	8.5	134	63.2±.48 (45.7–80.5)	5.58	8.8
E. g. placerensis	23	89.6±2.2 (66.4–103.2)	10.56	11.8	21	85.5±2.4 (62.6–108.1)	11.0	12.7
E. g. gilberti	59	91.3±1.4 (66.7–107.7)	11.0	12.1	31	82.4±1.1 (70.0–95.2)	6.34	7.7
E. g. cancellosus	31	86.9±1.6 (68–101)	8.73	10.1	35	84.3±.92 (69.6–98.6)	5.37	6.4
E. g. rubricaudatus	40	86.5±1.17 (67.3–113)	7.4	8.6	18	88.1±1.35 (71.1–107)	5.7	6.5
NUMBER OF SCALES FROM OCCIPUT TO BASE OF TAIL								
E. skiltonianus	253	57.8±.07 (51–62)	1.18	4.5	191	58.8±.09 (54–62)	1.18	4.7
E. g. gilberti	73	60.9±.17 (58–64)	1.44	2.4	48	61.0±.21 (58–64)	1.43	2.3
E. g. placerensis	50	60.8±.19 (58–63)	1.33	2.17	32	61.5±.23 (59–64)	1.3	2.1
E. g. cancellosus	43	58.94±.22 (56–62)	1.4	2.38	44	59.8±.17 (57–62)	1.09	1.85
E. g. rubricaudatus	49	61.1±.15 (58–63)	1.05	1.7	24	62.0±.26 (60–65)	1.25	2.0

TABLE 2

Length of Hind Leg/Snout–Vent Length × 100

Species or subspecies	Males				Females			
	No. of specimens	Mean (min.–max.)	σ	v	No. of specimens	Mean (min.–max.)	σ	v
E. skiltonianus	152	38.0±.13 (34.0–44.2)	1.6	4.2	108	35.7±.19 (30.8–40.8)	1.96	5.5
E. g. gilberti	56	36.2±.2 (32.7–39.8)	1.5	4.25	31	34.6±.28 (31.0–37.8)	1.57	4.5
E. g. placerensis	21	35.7±.27 (33.0–39.0)	1.6	4.5	20	34.6±.44 (31.2–38.3)	1.9	5.6
E. g. cancellosus	31	34.5±.32 (31.1–37.3)	1.75	5.07	37	33.2±.45 (29.3–39.0)	2.67	8.05
E. g. rubricaudatus	34	38.0±.33 (32.0–41.9)	1.94	5.1	16	35.4±.46 (31.0–39.6)	1.86	5.1

Length of Foreleg/Snout–Vent Length × 100

Species or subspecies	No. of specimens	Mean (min.–max.)	σ	v	No. of specimens	Mean (min.–max.)	σ	v
E. skiltonianus	151	26.3±.09 (23.2–29.4)	1.18	4.5	106	25.0±.11 (22.2–28.9)	1.18	4.7
E. g. gilberti	56	24.8±.13 (22.3–27.1)	.96	3.9	31	23.73±.14 (22.0–24.8)	.78	3.3
E. g. placerensis	23	24.6±.13 (22.4–26.7)	.61	2.5	21	24.2±.31 (22.4–26.8)	1.4	5.7
E. g. cancellosus	31	24.3±.26 (22.8–27.0)	1.43	5.9	37	23.55±.32 (20.7–27.6)	1.9	8.1
E. g. rubricaudatus	34	26.3±.31 (22.1–30.9)	1.78	6.8	16	24.6±.28 (20.6–27.4)	1.12	4.6

that is in line with the posterior edges of the femora (with the legs at right angles to the body).

In this character (see fig. 3, *d*) *cancellosus* falls below the other races of *gilberti*, thereby approaching *skiltonianus*. There seems to be a slight sexual difference in *skiltonianus, cancellosus,* and *rubricaudatus*, but none in *gilberti* or *placerensis*.

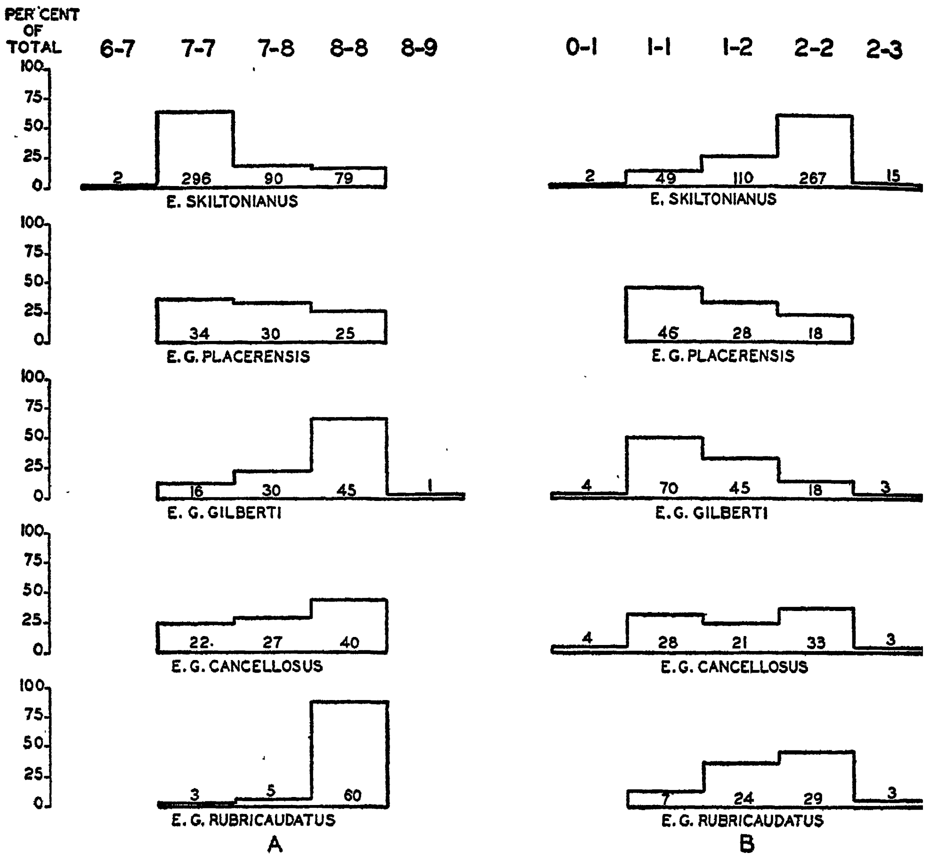


Fig. 4. Comparison of supralabials (*a*) and number of nuchals (*b*). Each vertical column represents a different condition of scalation, for example, 6–7 = 6 supralabials on one side and 7 on the other, 7–7 = 7 on each side, 1–1 = 1 pair of nuchals, 1–2 = 1½ pairs. Height of each column determined by per cent of total number of specimens. Number at bottom of each column indicates number of specimens having the condition indicated.

Supralabials.—The first supralabial is the first scale posterior to the rostral and the last is a large scale (larger than others of the row) that is invariably the second posterior to the subocular labial. When there are 8 supralabials, 5 lie between the rostral and the subocular labial; when there are 7, only 4 are found there.

The species *skiltonianus* differs radically from any race of *gilberti* in showing a strong tendency to develop but 7 supralabials on both sides. In the species *gilberti*, the races *gilberti, rubricaudatus,* and *cancellosus* have 8 supralabials

more commonly than 7. This is most often seen in *rubricaudatus,* where the condition of 7 on each side is rare, and is least often seen in *cancellosus,* where a total of 8 is only slightly more common than 7. *Placerensis* most nearly approaches *skiltonianus,* 8 or 7 occurring in about equal frequency (fig. 4).

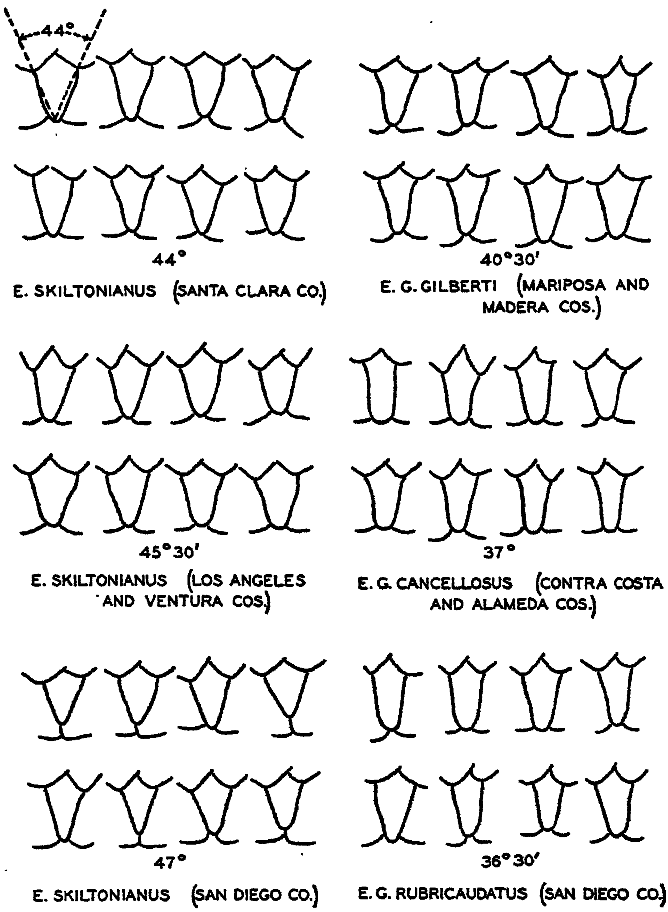


Fig. 5. Camera-lucida sketches of interparietal scale of a few typical specimens of *E. skiltonianus, E. g. rubricaudatus, E. g. gilberti,* and *E. g. cancellosus.* Angle at tip of each scale measured as indicated by dotted lines on sketch in upper left corner of the figure. Average angle for each group of specimens indicated below each group of sketches.

Paired nuchals.—These paired scales lie immediately behind the parietals. They are of much the same shape as other scales of the back but are about twice as large.

Among the races of *gilberti,* there is much more variation in the number of nuchals than in the number of supralabials (fig. 4). The strongest tendency for 2 pairs of nuchals is in *skiltonianus. Rubricaudatus* also has 2 pairs more frequently than 1, *cancellosus* has 1 or 2 in about equal frequencies, and *placerensis* and *gilberti* have 1 pair more frequently than 2.

Interparietal.—Taylor (1935) pointed out that specimens of *skiltonianus* from Todos Santos, Lower California, all had the parietals in contact behind

the interparietal and that this condition decreased slightly in frequency to the north of Lower California until it was found in 70 per cent of the specimens from San Diego County and about 10 per cent of those from west of the San Joaquin Valley. Seventy of our 100 specimens from San Diego County have the interparietal enclosed by the parietals posteriorly. In the San Jacinto and San Bernardino mountains and in the northern part of coastal Los Angeles and Ventura counties there is a sharp drop to slightly less than 10 per cent. Approximately this condition prevails throughout the rest of the range of *skiltonianus,* in California, and in *E. g. gilberti* and *E. g. placerensis.* In *E. g. cancellosus* and *E. g. rubricaudatus,* the percentage is nearer 1 or 2.

Though not more than 70 per cent of the *skiltonianus* and *rubricaudatus,* where they occur together, can be separated merely on the basis of whether or not the interparietal scale is enclosed by the parietals, Klauber (1939) pointed out that many more can be separated on the basis of the shape of the interparietal, for "in *skiltonianus* the interparietal is sharply wedge-shaped, while it is more blunt in *rubricaudatus,* the sides tending more toward parallelism." This character alone (see fig. 5) will serve to distinguish between *skiltonianus* and *rubricaudatus* in more than 90 per cent of the specimens encountered from San Diego and Los Angeles counties, and it serves nearly as well to distinguish between these forms in other parts of their ranges. It is also reliable to a degree of about 90 per cent in distinguishing between *skiltonianus* and *cancellosus,* but it is of practically no value in distinguishing *skiltonianus, gilberti,* and *placerensis.* The interparietals are more parallel-sided in *cancellosus* than in any other form. Since the difference in shape of the interparietal appears to be as useful taxonomically as is its enclosure by the parietals, an attempt was made to represent shape by measuring the angle at the apex between lines of contact with the frontoparietals. This angle was measured on camera-lucida drawings of 96 specimens (method of measurement and 46 of the drawings shown in fig. 5).

The angles for the specimens from each locality were averaged: 40 specimens of *skiltonianus* average 43° 36′; 32 specimens of *rubricaudatus* average 37° 15′; 16 specimens of *placerensis* average 40° 20′; 16 specimens of *gilberti* average 40° 30′; and 16 specimens of *cancellosus* average 37°. The angle is widest in *skiltonianus* from San Diego County, where the angle for *rubricaudatus* is narrowest, and the only place where the two species are known to occur together. Although the angle in *cancellosus* does not differ from that in *rubricaudatus,* the apical end is much wider and rounder in *cancellosus.* The specimens of *rubricaudatus* from Kern County, near the area of intergradation with *gilberti,* have the widest angle for the race, thus approaching *gilberti* in this character. The angle for *gilberti* and for *placerensis* is about the same and is only slightly narrower than that of *skiltonianus* in northern California; however, in general, it is nearer that of *rubricaudatus* than that of *skiltonianus.* The angle of the apex of the interparietal of one specimen of *E. lagunensis* (no. 13760, Mus. Vert. Zoöl.) is 53°.

ACCOUNTS OF SPECIES

Eumeces skiltonianus (Baird and Girard)

Plestiodon Skiltonianum Baird and Girard (1852: 69), original description, type locality, Oregon.
Eumeces skiltonianus var. *amblygrammus* Cope (1900: 643), type locality, Fort Humboldt.
Plestiodon skiltonianum, Grinnell and Camp (1917: 175, 176).
Plestiodon skiltonianus, Van Denburgh (1922: 578–587).
Eumeces skiltonianus skiltonianus, Taylor (1935: 415–428).

Range.—Southern British Columbia to northern Lower California, and east to western Montana and Utah.

In California, this species has been found across the entire northern part of the state and along the entire coast. It has been found in the Sierra Nevada as far south as Placer County (at the yellow pine level) and Yuba County (at the digger pine level). In the Sacramento Valley it ranges as far south as the Marysville Buttes, in northern Sutter County. Along the coast north of San Francisco Bay it has been found throughout the Coast Ranges. South of San Francisco Bay and north of Monterey Bay it is replaced along the inner side of the hills of the Coast Ranges by *E. gilberti cancellosus.* South of Monterey Bay as far as San Luis Obispo County it is again replaced along the inner hills by the species *gilberti*; the population here is intermediate between *cancellosus* and *rubricaudatus.* In the part of the state south of San Luis Obispo County, *skiltonianus* occurs rather generally south and west of the deserts, throughout the San Gabriel and San Bernardino mountains, in the San Jacinto and Santa Rosa mountains, and over most of the country from these mountains to the coast. Most of this area is also occupied by *E. gilberti rubricaudatus.* Although *skiltonianus* occurs higher in the mountains and *rubricaudatus* has not yet been reported within 15 miles of the coast, their ranges overlap in most of this area and there are seven localities in San Diego County from which both species have been collected. *Skiltonianus* also occurs on Santa Catalina Island, on Los Coronados Islands (Lower California), and on the peninsula as far south as latitude 29° north.

Some specimens from Kaweah, Taver, and Monache meadows, Tulare County, doubtfully referred to *skiltonianus* by Taylor (1935: 428), are here considered to belong to the species *gilberti.*

Species characters.—Tail color of young bright blue; although blue dulls to gray-blue with age, this color is retained throughout life in many individuals; sharply defined color pattern retained throughout life, although reduced in some old individuals; maximum size 75 to 83 mm. snout to vent; legs relatively long, especially in males. Scales of back relatively larger (average 57 to 59 between occiput and base of tail); 7 supralabials usual, 2 pairs of nuchals usual; interparietal short and obtuse. For further details, see discussion of characters.

Comparison with other forms.—Resembles *E. g. gilberti* and *E. g. placerensis* in type of color pattern and in having bright blue juvenal tail color, but

differs from either in that blue tail color and sharply defined color pattern retained much longer and scales of dorsolateral light lines not edged with brown or gray. Smaller than any race of *gilberti;* 7 upper labials and 2 pairs of nuchals more frequent; relatively larger scales on back. In size, most nearly

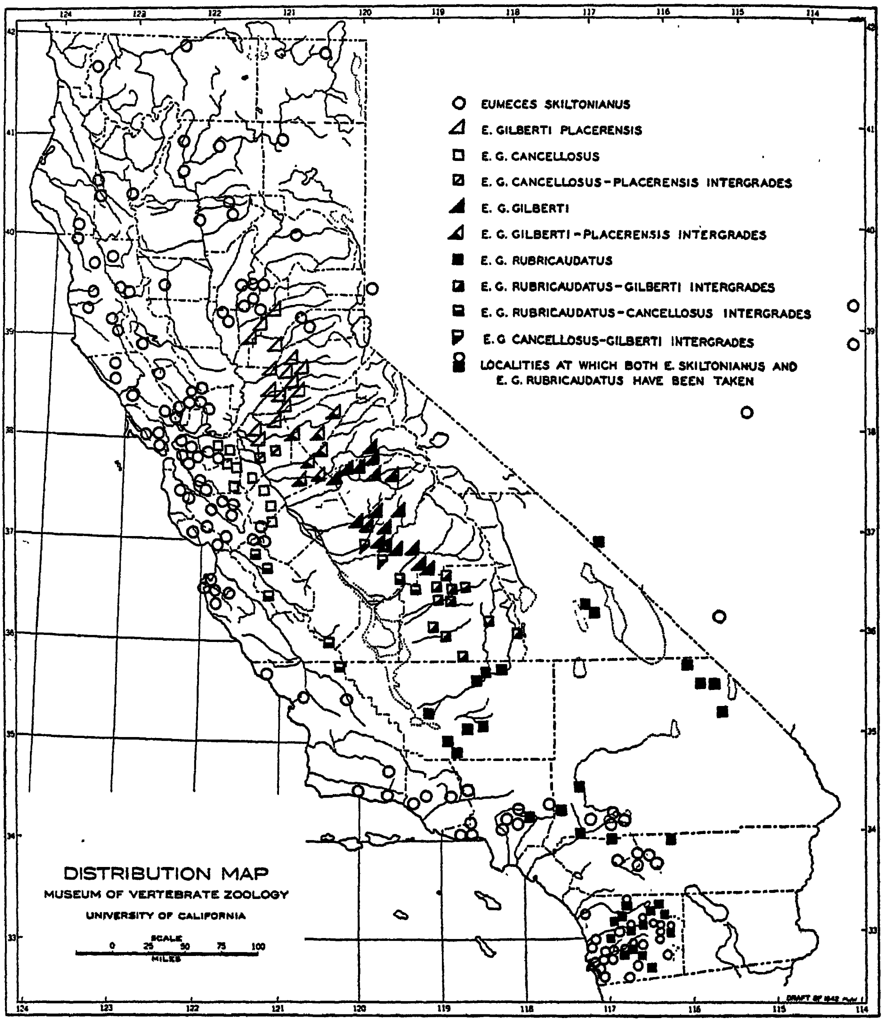


Fig. 6. Map showing localities from which specimens have been examined by the authors. Different symbols show the distribution of the forms and intermediate populations. Four locality records for *E. skiltonianus* in central Nevada are obscured by legend.

approached by *cancellosus,* which, however, has much different type of color pattern and pink juvenal tail color (pl. 8, *a, d*). *Skiltonianus* differs most strikingly from *rubricaudatus,* the only form with which it is known to occur geographically.

Geographic variation.—The study of geographic variation in this species was confined to the parts of the range where it adjoins or overlaps the ranges of other forms. This variation was found to exist in every character examined,

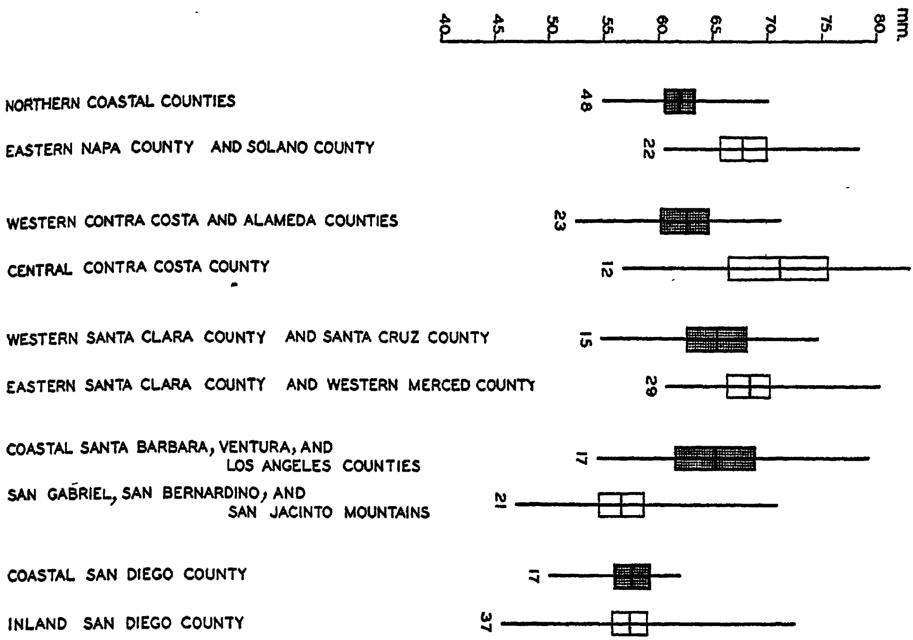


Fig. 7. Comparison of snout-vent length of specimens of *E. skiltonianus* from near coast with those from hills of the inner Coast Ranges at five different places in California.

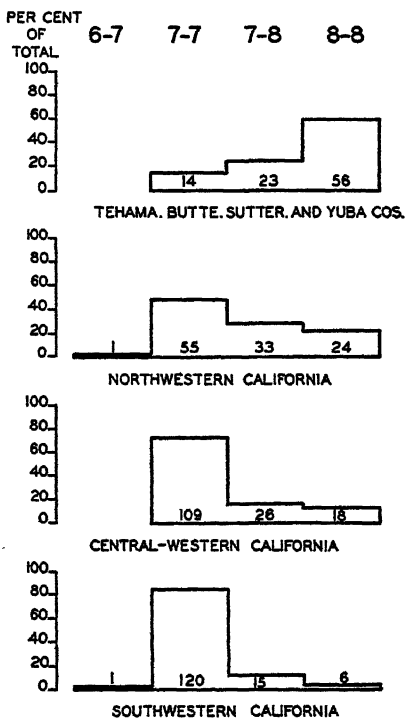


Fig. 8. Comparison of percentage occurrence of numbers of supralabials in four different populations of *E. skiltonianus* in California. Horizontal position of different columns indicates condition of supralabials, for example: 7–7 = 7 supralabials on each side; 7–8 = 7 on one side and 8 on the other. Number of specimens involved is indicated at the base of each column.

although the magnitude of the variation in most characters is not great and the trends in the different characters often are not regular and usually do not parallel each other.

Along the immediate coast there is a tendency toward black pigmentation in the pattern, and the color is often diffuse (not sharply restricted to certain areas on each scale). This has been observed in northern Lower California, and in San Diego, Ventura, Monterey, Sonoma, and Mendocino counties in California, and is probably true along the entire coast. A few miles away from the coast, in San Diego, southern Los Angeles, Ventura, Santa Clara, Contra

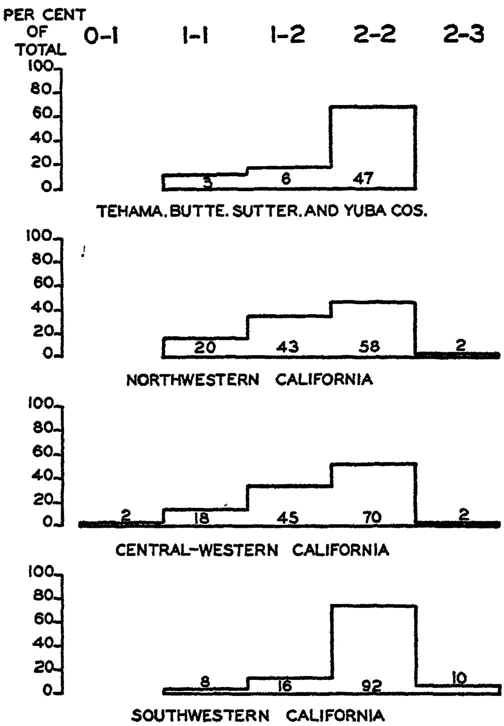


Fig. 9. Comparison of percentage occurrence of numbers of nuchals in four different populations of *E. skiltonianus* in California. Horizontal position of different columns indicates condition of nuchals, for example: 1–1 = 1 pair, 1–2 = 1½ pairs. Number of specimens involved is indicated at the base of each column.

Costa, Solano, and Tehama counties, there is a tendency toward development of less black pigment and strong reduction of the color pattern in large adults. Neither of these tendencies is found in the inland population of the San Bernardino Mountains or of the northern Sierra Nevada (in Butte County).

Along the immediate coast, the average snout–vent length in populations north of San Diego County averages greater than in populations south of there. In the populations of the inner Coast Ranges immediately east of San Francisco Bay the snout–vent length is significantly greater. This difference between coastal and interior populations is slight or absent in the area south of San Francisco Bay and north of Monterey Bay, and it is reversed in southern California north of San Diego County (fig. 7). The inland population here

does not differ significantly from that of either coastal or interior San Diego County or from that of Lower California (mean for Lower California, including Los Coronados Islands, 58.4 ± .73 mm.). An interior population from northern California, that from Tehama, Plumas, Butte, Sutter, and Yuba counties, exhibits about the same snout–vent length as coastal populations of northern California (mean = 63.9 ± .73 mm.).

From south to north, west of the deserts and the Great Valley, there is a gradient in frequency of occurrence of 7 supralabials. It is highest in San Diego County and lowest in the north coast counties of California. In Tehama, Butte, Sutter, and Yuba counties, there is a sharp reduction in occurrence of 7; here 8 is more common. (See fig. 8.)

The possession of 2 pairs of nuchals is more common in specimens from San Diego County than from anywhere else along the coast north to Oregon, but no more common than in those from Tehama and Butte counties (fig. 9). In this character, the populations in northwestern and west-central California do not differ significantly from *E. g. rubricaudatus*. However, the population in southwestern California, where *skiltonianus* is most closely associated with *rubricaudatus*, differs markedly from it.

Geographic variation in condition of interparietal within the range of *skiltonianus* is discussed on pages 191, 192 and is represented in figure 5.

Localities from which specimens of Eumeces skiltonianus have been examined.—WASHINGTON. *Spokane County:* Spokane; Cheney, 10 mi. SW Spokane. *Grant County:* Dry Falls, Grand Coulee.

OREGON. *Wasco County:* Mill Creek, 10 mi. SW The Dalles. *Umatilla County:* Pendleton. *Wheeler County:* 11 mi. W and 7 mi. S Mitchell, 4,850 ft. *Lane County:* N side Spencer's Butte, 5 mi. W Eugene. *Deschutes County:* Deschutes River, 4 mi. W Redmond. *Curry County:* 5 mi. S Port Orford; 1 mi. W Lobster Creek, Rogue River. *Jackson County:* 5 mi. E Eagle Point; 5 mi. NE Beagle; Anderson Creek; Wagner Gap; 10 mi. E Ashland; Upper Squaw Lake.

IDAHO. *Latah County:* Robinson Lake, 7 mi. NE Moscow. *Nez Perce County:* Lewiston (CAS). *Ada County:* Boise (CAS). *Bingham County:* Fort Hall (CAS).

MONTANA. *Ravalli County.*

CALIFORNIA. *Siskiyou County:* Clear Creek, 1,400 ft., 3 mi. W Klamath River; Fort Jones (SNHM). *Modoc County:* Fort Bidwell (USNM). *Humboldt County:* Benbow. *Trinity County:* 3½ mi. N Mad River Bridge, South Fork Mountain; Mad River at Olsen's Creek, 2,500 ft.; Reilly's Ranch, 2,950 ft.; divide, 12 mi. N North Yolla Bolly Mountain, 4,400 ft. *Shasta County:* Clear Creek, near Delta (LAM); Anderson (SNHM); Pit River (CAS): 7½ mi. N Redding. *Lassen County:* Pit River (CAS). *Tehama County:* 6 mi. NE Red Bluff, 350 ft.; 4 mi. SE Manton, 3,000 ft.; Old Lyonsville, 3,500 ft.; Turner's, Lyonsville P.O., 3,500 ft. *Plumas County:* Keddie. *Mendocino County:* South Fork Eel River, ½ mi. S Humboldt County line; Frank Clark's Ranch, 7 mi. SW Laytonville; Cahto; Covelo (CAS): 3 mi. S Covelo, 1,750 ft.; 10 mi. W Willits; 3 mi. W summit of Sanhedrin Mountain, 4,500 ft.; Comptche (CAS): Lake Leonard, 10 mi. NW Ukiah; 6 mi. ESE Ukiah (on U.S. Highway 101). *Glenn County:* 9 mi. S Elk Creek. *Butte County:* Oroville; 1 mi. NE Oroville; 6 and 12 mi. W Woodleaf (Yuba County); 6 mi. E Oroville; 3 mi. E Honcut; Bangor. *Lake County:* Lakeport; Kelseyville (SNHM). *Sutter County:* 2 mi. NW North Butte, 450 ft.; 1⅛ mi. S South Butte, 350 ft.; 2 mi. SE South Butte, 400 ft. *Yuba County:* North side Yuba River, 300 ft.; 3 mi. NW Smartville, *Placer County:* 1 mi. NE Towle; Red Point (SNHM). *Sonoma County:* Skagg Springs (CAS); 2 mi. S Cazadero; 7 mi. W Cazadero, 900 ft.; Camp Meeker (CAS); Agua Caliente (CAS); Eldridge (CAS). *Napa County:* 3 mi. W Calistoga; Napa; 2 mi. SW Napa, 200 ft.; Huichica Creek, 5½ mi. W Napa, 250 ft; 5 mi.

SE Monticello; Suisun Creek, 480 ft.; 4 mi. NNW Manka. *Solano County:* 7 mi. SSW Winters; 3 mi. NW Vacaville; 3 mi. N Vacaville, 700 ft.; 3 mi. W Vacaville, 700 ft.; old quarry, 4 mi. NNE Fairfield. *Marin County:* Lagunitas (CAS); Woodacre; Fairfax; between Fairfax and Alpine Dam; San Anselmo; Rock Springs (CAS); San Rafael (CAS). *Contra Costa County:* Pinole; Wildcat Canyon; Grizzly Peak; Bald Peak; Redwood Canyon; St. Mary's College; west side Mount Diablo, 900 ft.; Pine Canyon, Mount Diablo; Mitchell Canyon, north side Mount Diablo; Black Hills, 1,900 ft.; 4 mi. SSW Mount Diablo; 3.7 mi. SE Mount Diablo; Marsh Creek, 1,500 ft.; 4.1 mi. NE Tassajara; Marsh Creek, 1,000 ft.; 4.1 mi. ESE Mount Diablo; Marsh Creek, 500 ft.; 4.6 mi. E Mount Diablo. *Alameda County:* Berkeley; Strawberry Canyon; Claremont Canyon; hills E Oakland; Sunol (SNHM); south slope Mission Peak, 3 to 4 mi. E Mission San Jose. *San Mateo County:* Hillsboro (CAS). *Santa Clara County:* Stanford University (LMK); College Park (SNHM); Alum Rock Canyon (SNHM); Mount Hamilton (SNHM); Smith Creek (SNHM); Wrights Station (SNHM); Ruckers, Uvas Valley (SNHM); 1 mi. E Bell Station; 2 mi. E Pacheco Peak; 1 mi. W summit Pacheco Pass; 1½ mi. E summit Pacheco Pass. *Merced County:* 2½ mi. NE Pacheco Peak (Santa Clara County); 4 mi. S Pacheco Pass. *Santa Cruz County:* Waddell Creek; 1 mi. W Ben Lomond; Corralitos (SNHM). *Monterey County:* Monterey (CAS); Carmel (CAS); 7 mi. E Carmelo School; San Clemente Creek, 11 mi. ESE Carmel Mission; Big Pines, 3,900 ft.; Jamesburg (CAS); 5 mi. W Jolon, 1,250 ft. *San Luis Obispo County:* Hearst's Ranch, 1 mi. E San Simeon; 6 mi. W Atascadero; La Panza. *Santa Barbara County:* Big Pine, 6,400 ft.; 20 mi. N Santa Barbara; Santa Barbara (LMK); Montecito (LMK). *Ventura County:* 3 mi. S Nordhoff; Weldons (LAM); Pole Creek, 1¾ mi. NE Fillmore. *Los Angeles County:* Oak Flat, 10 mi. NNW Castaic; Calabassas (LAM); Corral Canyon, Santa Monica Mountain (SDSNH); Las Flores Canyon, Santa Monica Mountain (LAM); Swartout (LMK); Barley Flats, 6,000 ft.; 8 mi. NE Pasadena, San Gabriel Mountains; La Crescenta (CAS); Sierra Madre, 2,500 ft.; Bailey Canyon, Sierre Madre; foothills near Pasadena; Arroyo Seco, near Pasadena; Glendale (LMK). *San Bernardino County:* Lake Arrowhead (LAM); Barton Flats, 6,000 ft. (LMK); Big Bear Lake (LAM); Santa Ana River, 5,500 ft.; Seven Oaks, Waterman Canyon (LAM); South Fork Santa Ana River, 6,200 ft.; Fish Creek, 6,500 ft. *Riverside County:* San Jacinto (SNHM); San Jacinto River, 3 mi. E San Jacinto; First Mill Site, Fuller's Mill Road, 5,300 ft.; Snow Creek (SNHM); Palm Springs (LAM); Strawberry Valley, 5,500 ft.; San Jacinto Mountains. *San Diego County:* Pauma Camp, San Luis Rey (LMK); Upper Doane Valley* (LMK); Escondido (LAM); San Pasqual* (LAM); Witch Creek* (CAS); Julian (LMK); Banner*; Miramar (LAM); Camp Kearny (SDSNH); Poway (SDSNH); Barona Ranch (LMK); Ramona* (SDSNH); El Capitan* (LMK); Pine Hills (SDSNH); Cuyamaca (LMK); 4 mi. N Cuyamaca; Murray Dam (LAM); Suncrest* (LMK); Point Loma (SDSNH); Balboa Park, San Diego (LMK); San Diego State College, 7 mi. ENE San Diego; National City (LMK); Chula Vista; Monument 258 (SDSNH); Alvarado Canyon (SDSNH); La Mesa (LAM); Indian Springs (LMK); Lakeside (LMK); Alpine (LMK); Viejas (LMK); Dulzura (SNHM); La Puerta Valley (LAM); Lyons Valley (LMK); Deerhorn Flat (LMK); Laguna; Laguna Mountains (LMK); Boiling Springs, Laguna Mountains.

NEVADA. *Washoe County:* 8 mi. W and 1½ mi. N Reno. *Lander County:* Kingston Creek, 7,000 ft.; Toyabe Mountains. *White Pine County:* 2 mi. W Smith Cave, 6,300 ft.; Mount Moriah; Baker Creek, 6,300 ft., Snake Mountains. *Nye County:* Mohawk Ranger Station; 1 mi. E Jefferson, 7,600 ft., Toquima Mountains; Scofield Canyon, 8,000 ft., Grant Mountain. *Clark County:* Charleston Park, 7,500 ft. (U.C.L.A.)

LOWER CALIFORNIA. Los Coronados Islands (SDSNH); North Island, Los Coronados Islands; East Island, Los Coronados Islands (CAS); South Island, Los Coronados Islands (LMK); North Todos Santos Island (CAS); South Todos Santos Island (CAS); Ensenada (CAS); 6 mi. SE Cape Colnett (CAS); San Jose (LMK); Rancho San José (CAS); Alcatraz, San Pedro Mártir Mountains (CAS); Arroyo Encantada (CAS); La Grulla; San Quentín (CAS).

* Localities where *E. g. rubricaudatus* has also been taken.

Eumeces gilberti gilberti Van Denburgh

Eumeces gilberti Van Denburgh (1896: 350–352), original description, type locality, Yosemite Valley, Mariposa County, California.
Eumeces skiltonianus brevipes Cope (1900: 643); type locality, Fresno, California.
Plestiodon skiltonianum, Grinnell and Camp (1917: 175, 176).
Eumeces gilberti gilberti, Taylor (1935: 438–446).

Range.—Sierra Nevada, below 5,500 feet, from Tuolumne County south to southern Fresno County, and possibly at higher elevations, to southeastern Tulare County. Intergrades with *placerensis* in northern Tuolumne, Calaveras, and eastern Stanislaus counties, and with *rubricaudatus* in northwestern Tulare County.

Racial characters.—Tail color of young bright blue; color lost before individual reaches 50 per cent of maximum size for race; maximum size 107 mm. Color pattern usually completely lost before snout–vent length reaches 65 mm.; dark margin on scales of dorsolateral light lines. Body of adults uniformly brown, green, or blue-green; tail same as back or else reddish or purplish; head nearly same as body or red. Legs relatively short; sexual dimorphism in size and leg length. Scales of back relatively smaller (average 61 between occiput and base of tail); 8 supralabials more frequent than 7; 1 pair of nuchals usual; interparietal not distinctive.

Comparison with other forms.—Young similar in appearance to *placerensis* and *skiltonianus*; differ from latter in presence of dark margin on scales of dorsolateral light lines, and number of supralabials; differs from former in average number of supralabials, in time of loss of color pattern, and sexual dimorphism in color pattern. Adult males difficult to distinguish from *placerensis*, but females and smaller males distinguishable by presence of color pattern in *placerensis*.

Geographic variation.—Typical *E. g. gilberti* loses its color pattern earlier than any other form (pl. 8, *c*). At the extreme southern part of the range many individuals retain some dark pigment on the sides into adulthood, and a few young specimens from there have some dark pigment on the back bordering the posterior edge of the scales of the first scale rows. Both these characters represent an approach toward *rubricaudatus*. Along the eastern edge of the valley floor mixed populations have been found that are probably the result of crossing with a *cancellosus*- or *rubricaudatus*-like population that is not now known to inhabit adjacent territory.

Remarks.—The specimen designated as the type of Cope's *E. skiltonianus brevipes* was taken a few miles southeast of Fresno and is probably intermediate in character between *gilberti* and *rubricaudatus*. The name *brevipes* would have precedence over the more recently described *rubricaudatus* if identified with that race. However, the type of *brevipes* and other available specimens of the intergrading population to which it belongs, are, on the whole, nearer to the race *gilberti*. Hence *brevipes* is considered to be a synonym of *gilberti*.

Localities from which specimens of Eumeces gilberti gilberti have been examined.—*Tuolumne County:* Swamp Lake (Yos. Mus.); Miguel Meadow (Yos. Mus.); Mather Ranger

Station (Yos. Mus.). *Mariposa County:* Pleasant Valley; near Kinsley, 2,800 ft.; Dudley, 3,000 ft.; Smith Creek, 3,000 ft.; 6 mi. NE Coulterville; 3 mi. NE Coulterville; Yosemite Valley (CAS); near Sheep Gap, 1,700 ft., 4½ mi. SE Cathay School; Anderson Flat, 3,400 ft. *Madera County:* Hesvel, 540 ft., 8 mi. W Raymond; Raymond, 940 ft.; 6 mi. NE Knowles; Northfork; San Joaquin Experimental Range, near O'Neals. *Fresno County:* 2 mi. SE Friant; 5 mi. NE Clovis; 2 mi. NE Academy; Trimmer; 1 mi. W Dunlap; 6 mi. W. Pinehurst. *Tulare County:* Upper Funston Meadow; Little Lake, 6,200 ft.; Monache Meadows, 8,000 ft.; Quaking Aspen Meadow; White River (SNHM).

Localities from which specimens intermediate between gilberti and rubricaudatus have been examined.—Tulare County: Whitaker's Forest, 5,500 ft., 10 mi. NE Badger; 4 mi. ESE Dinuba; 8 mi. SW Badger; North Fork Kaweah River, 2,000 ft., Sequoia National Park; Generals Highway, 100 yards above Smith Grade telephone, Sequoia National Park; Generals Highway, 4,500 ft., Sequoia National Park; Power House No. 3, Sequoia National Park; flume truck trail, 2,100 ft., Sequoia National Park; 1 mi. NW Lemon Cove; 2 mi. W Three Rivers; Knob Hill, about 1½ mi. SE Lindsay; Rock Hill, about 5 mi. NE Lindsay; Strathmore; 4 mi. SE Porterville.

Eumeces gilberti cancellosus, new subspecies*

Type.—Adult female, no. 24034, Mus. Vert. Zoöl., collected by H. S. Fitch, 8 mi. W and 1.1 mi. S Altamont, 900 ft., Alameda County, California (pl. 9), May 4, 1937; original no. 3348.

Range.—Eastern Contra Costa and Alameda counties, southwestern San Joaquin County, and northwestern Merced County, California. Intergrades with *rubricaudatus* through a population that occurs in San Benito, eastern Monterey, western Fresno, eastern San Luis Obispo, and western Kern counties, and possibly also on the floor of the upper part of the San Joaquin Valley.

Racial characters.—Tail color of very young individuals pink (p. 183), with a distinct wash of blue on the dorsal surface; dorsolateral and lateral light stripes sharply defined; area between lateral and dorsolateral light lines dark brown in youngest individuals; area between dorsolateral light lines also dark brown, but with indistinct vertebral stripe of lighter brown extending from base of tail to top of head and often with transverse extensions along anterior part of each scale of first scale rows (pl. 8, *d*); top of head also lighter brown. Tail color of large young (snout–vent length 55–65 mm.) less pink or with no pink; blue dorsal wash turned to gray; dorsolateral light lines still clearly defined but lateral lines blend in with light belly color; dark areas on sides and back broken by restriction of dark pigment to distal half or one-third of individual scales. Tail color of adult individuals (65 mm. or more) same as ground color of back and sides; dark pigment restricted to distal one-fourth or one-third of each scale in dorsal and lateral areas; traces of dark areas extend out onto tail in many females and young adult males, producing latticed pattern as shown on type specimen (pl. 9). In some old females, dark pigment further restricted, but at least enough remains to outline position of dorsolateral lines. Old males lose all dark pigment and all trace of light lines, leaving back, sides, and tail entirely uniform (pls. 8, *d*, 9). Some adult males have reddish orange head during spring and summer (pp. 178, 179). Adults reach

* The name *cancellosus* is descriptive of the latticed pattern of dark dorsal markings typical of adult females of this race.

maximum size of 98 mm. (table 1, fig. 3, *a*); little if any sexual dimorphism in size (fig. 3, *a*); leg length relatively short, showing little or no sexual dimorphism (fig. 3, *b* and *c*). Scales from occiput to base of tail average 59.4 (table 2, fig. 3, *d*); supralabials 7 to 8, the latter number slightly more frequent (fig. 4, *a*); nuchals either 1 or 2 pairs in about equal frequency (fig. 4, b); interparietal with nearly parallel sides and with widely rounded apical end (fig. 5).

Comparison with other forms.—Juvenal tail color closely resembles that of *rubricaudatus* but has blue wash dorsally (does *not* approach *skiltonianus* or *gilberti* in blueness); color pattern of back and sides of youngest specimens resembles that of other races of *gilberti* and, to some extent, some *skiltonianus* (pl. 8). Large young can be distinguished from *E. g. gilberti* or any *E. skiltonianus* by barred arrangement of dark pigment on scales of first scale rows (pl. 8). Barred or latticed effect more prominent in *cancellosus* than in *rubricaudatus* and longer retained (pl. 8, *d*, *e*). Head color of breeding individuals lighter than in *E. g. gilberti* (pp. 178, 184, 185), probably like that of *rubricaudatus*. Size about same as in other races of *gilberti*; much larger than *skiltonianus* (fig. 3, *a*); differs from *gilberti* and resembles all other forms in having little or no sexual dimorphism in size. Males resemble *gilberti* and *placerensis* in shortness of legs and *placerensis* in lack of sexual dimorphism in leg length (fig. 3, *b* and *c*). Intermediate between *placerensis* and *gilberti* in condition of supralabials (fig. 4, *a*); intermediate between *gilberti* and *rubricaudatus* in condition of nuchals (fig. 4, *b*); interparietal extremely parallel-sided and round-ended, but most nearly resembling *rubricaudatus* (pp. 191, 192, fig. 5). For further discussion of the relationships between *cancellosus* and other forms, see pages 181, 182.

Localities from which specimens of E. g. cancellosus have been examined.—*Contra Costa County:* 1 mi. S Pittsburg; Kirker Creek, 450 ft., 2⅛ mi. NNW Nortonville; Nortonville; ⅝ mi. SW Nortonville, 1,150 ft.; Marsh Creek, 500 ft., 4.8 mi. E Mount Diablo; Marsh Creek, 210 ft., 5 mi. W Byron; 6¾ mi. WSW Byron; Kellogg Creek, 300 ft., 3½ and 4½ mi. WSW Byron; Arroyo Cavelano, 800 ft., 7 mi. NW Livermore (Alameda County). *Alameda County:* 2 mi. SE Livermore; Arroyo Mocho, 7 mi. SE Livermore; Tesla, 900 ft., Corral Hollow. *San Joaquin County:* Corral Hollow, 450 ft., 7 mi. SSW Tracy; Hospital Canyon.

Cancellosus-rubricaudatus intermediates.—*Cancellosus* intergrades with *rubricaudatus* through a large population that occupies parts of at least five counties, extending from about opposite Monterey Bay to the upper end of the San Joaquin Valley, along the inner hills of the Coast Ranges. *Cancellosus-rubricaudatus* intermediates also occur on the eastern side of the San Joaquin Valley and probably occur as well on the floor of that valley. This intermediate population ranges into the Tehachapi Mountains where it blends imperceptibly into *rubricaudatus*. Specimens from a population around Parlier, Fresno County, and Smith Mountain and Dinuba, Tulare County, are also intermediate between *cancellosus* and *rubricaudatus*.

Localities from which specimens intermediate between cancellosus and gilberti have been examined.—*Madera County:* Madera; Nelda S. Brown Ranch, 400 yds. S Fresno River, 3½ mi. NE Madera. *Fresno County:* R. K. Smith Ranch, 6½ mi. NE Clovis; 5 mi. NE Clovis.

Localities from which specimens intermediate between cancellosus and rubricaudatus have been examined.—*San Benito County:* French's Pass, 10 mi. NE Hollister; Lonetree Pass, 5½ mi. NE Hollister; Las Cimas Ranch, 2½ mi. NNE Hollister; 9 mi. E Tres Pinos; 6 mi. N Emmet; Walter's Ranch, 5 mi. E Paicines; Pinnacles National Monument (SNHM). *San Luis Obispo County:* Polonio Pass, 5½ mi. E Cholame (on Kern County line). *Fresno County:* Parlier. *Tulare County:* South slope of Smith Mountain, 500–800 ft.; 3 and 4 mi. SE Dinuba.

Eumeces gilberti placerensis Rodgers

Plestiodon skiltonianum, Grinnell and Camp (1917: 175, 176).
Eumeces skiltonianus brevipes, Taylor (1935: 428–431).
Eumeces gilberti placerensis Rodgers (1944: 101–104), original description; type locality, 6 mi. E Smartville, Nevada County, California.

Range.—Foothills of Sierra Nevada, below 2,500 feet, in southern Yuba, Placer, Sacramento, Eldorado, Amador, and San Joaquin counties. Also, on the floor of the Great Valley east of the San Joaquin River in San Joaquin County. The northern limit of the range is the south bank of the Yuba River, on the north bank of which *Eumeces skiltonianus* occurs. The range of *skiltonianus* extends south of the Yuba River at 4,000 feet elevation in Placer County. In Calaveras and Stanislaus counties *placerensis* intergrades with *gilberti*. Specimens from central San Joaquin County indicate occasional or former breeding with *cancellosus* or a *cancellosus*-like population that probably once occupied, and may still occupy, parts of the floor of the San Joaquin Valley.

Racial characters.—Tail color of young bright blue; color retained until individual reaches about 67 per cent (60–65 mm. snout–vent length) of adult size for race; maximum length 108 mm. (snout–vent). Color patterns sharply defined in young, lost in adult males, but some trace, at least on sides, in all females; dark margins on scales of dorsolateral light lines. Body and tail of adult males uniformly greenish or brownish on back and sides, head sometimes red. No sexual dimorphism in size and little or none in limb length; legs relatively short. Scales of back relatively small (average 61 between occiput and base of tail); 7 supralabials more common than 8; one pair of nuchals more common than two; interparietal not distinctive.

Comparison with other forms.—Differs from *E. skiltonianus* in larger size, earlier loss of color pattern, sexual dimorphism in color pattern, higher frequency of 8 supralabials, one pair of nuchals, relatively smaller scales on back, and presence of dark edging on scales of dorsolateral light lines. Differs from *gilberti* in longer retention of juvenal color and color pattern, more sexual dimorphism in color pattern but none in size, and higher frequency of 7 supralabials.

Geographic variation.—The population on the floor of the Sacramento Valley, in San Joaquin County, probably retains the color pattern longer and may average smaller in snout–vent length than populations in other parts of the range.

Remarks.—The series of specimens from Eldorado County to which Taylor wrongly applied the name *Eumeces skiltonianus brevipes* are all large young *placerensis*. He had one specimen, an adult male, from Eldorado County that

was without color pattern; he recognized it as *gilberti* but concluded that the place of collection was wrong on the label.

In his diagnosis of *"brevipes,"* Taylor wrote: "Related to *skiltonianus skiltonianus*, but larger and more robust, the body proportionately more elongate, the scales having a more glossy appearance. The tail lavender, a color retained more or less in adults." Since these specimens belong to the species *gilberti*, it would be expected that they would be larger, more robust, and would have a proportionately more elongate body than in *skiltonianus*. Our observations on the original series, and on many other specimens from the same area, fail to substantiate the character of "more glossy appearance." Taylor's series of specimens have been in preservative since 1896, and chances are great that the now lavender tails were once blue. Blue-tailed specimens have been taken at other localities in the same county. Since his specimens are not adult, as he assumed, the statement that juvenal tail color is "retained more or less in the adults" is invalid.

Localities from which specimens of Eumeces gilberti placerensis have been examined.—*Yuba County:* 9 mi. NE Wheatland; 12 mi. NE Wheatland. *Nevada County:* 4 mi. SSW French Corral; 5 mi. SW Bridgeport; 6 mi. E. Smartville (Yuba County); north side Deer Creek, 2,900 ft., 1 mi. N Nevada City; 8 mi. W Grass Valley. *Placer County:* 7 mi. NW Auburn, *Sacramento County:* 3 mi. NE Folsom (LMK); 1 mi. W Michigan Bar, 200 ft. *Eldorado County:* 12 mi. NW Placerville; 12 mi. W and 4 mi. S Placerville, 1,200 ft.; 2 mi. S Placerville; Sugar Loaf Post Office (SNHM). *Amador County:* 10 mi. WSW Plymouth; 1 mi. SE Plymouth; 1 mi. N Carbondale; 5 mi. E. Carbondale. *San Joaquin County:* 1 mi. E Clements; 6 mi. N Lodi; 1 mi. N Lodi.

Localities from which specimens intermediate between placerensis and gilberti have been examined.—*Calaveras County:* Big Trees (SNHM), 2 mi. S Angels Camp. *Stanislaus County:* Northeast of Cooperstown, on Tuolumne County line; Hickman; La Grange; Berkeley Tuolumne Camp, 3,500 ft., Big Oak Flat Road. *Tuolumne County:* 9 mi. W Yosemite Junction.

Localities from which specimens intermediate between placerensis and cancellosus have been examined.—*San Joaquin County:* Stockton; 7 mi. ESE Stockton; Lathrop.

Eumeces gilberti rubricaudatus Taylor

Eumeces gilberti rubricaudatus Taylor (1935: 446–451), original description; type locality, Tehachapi Mountains, California.
Plestiodon skiltonianum, Grinnell and Camp (1917: 175, 176).
Plestiodon skiltonianus, Van Denburgh (1922: 578–587).
Eumeces gilberti, Grinnell (1908: 163, 164).

Range.—Southern California, extreme northern Lower California, extreme southwestern Nevada, and west-central Arizona (Taylor, 1935: 446, fig. 72).

In California this race has been found in the mountains of Riverside and eastern San Diego counties and west throughout the lower hills, but not within 15 miles of the coast. It has been taken at five localities in the San Gabriel and San Bernardino mountains and just north of these mountains on the Mohave River. It occurs in the Tehachapi Mountains and in the southern Sierra Nevada where it ranges up the Kern River valley to northern Kern County and along the western foothills to west-central Tulare County. In northern Tulare County it intergrades with *gilberti*. West of the San Joaquin Valley

it intergrades, through a widespread intermediate population, with *cancellosus*. The race *rubricaudatus* has also been found in some of the desert mountain ranges in northeastern San Bernardino and southern Inyo counties (also just over the line in Nye County, Nevada).

Racial characters.—Tail color of young clear pink; color lost before individual reaches 50 per cent of maximum size; maximum size 113 mm. Color pattern usually completely lost by time snout–vent length reaches 65 or 70 mm. (later for females than males); pattern between dorsolateral light lines consists of a row of transverse bars on each scale row. No sexual dimorphism in size; legs relatively long (more so in males than females); 8 supralabials; 2 nuchals more often than 1; interparietals nearly parallel-sided with narrow angle at apex.

Comparison with other forms.—Young individuals very closely resemble *cancellosus* but are without blue wash on dorsal surface of pink tail; color pattern lost earlier than in *cancellosus*, especially in females; ground color in patternless adults more tannish and less greenish than in *gilberti*. Medium-sized individuals without pink tail which have not lost their color pattern can be distinguished from *skiltonianus* by presence of barred pattern on back (pl. 8, *e*), more parallel-sided interparietal, more frequent occurrence of 8 supralabials, and relatively smaller scales on back (higher scale count from occiput to base of tail).

Geographic variation.—Although there are not enough specimens available to make a detailed study, the material at hand suggests that this form differs in each of the major parts of the range. Those from the areas west of the deserts resemble each other in size and early loss of color pattern, but the condition of 8 supralabials is more common in the south. Those from the desert mountains are smaller and retain their color pattern longer. They are considered to be *rubricaudatus* on the basis of adult and subadult characters. However, no young specimens have yet been seen and until they have been we cannot be sure that the juvenal tail color is pink.

Localities from which specimens of Eumeces gilberti rubricaudatus have been examined.—CALIFORNIA. *Inyo County:* Johnson Canyon, 6,000 ft.; Panamint Mountains; Surprise Canyon, Panamint Mountains (CAS). *Kern County:* Kern River, 2,500 ft., near Isabella; Onyx, 2,750 ft.; Kern River, 2,000 ft., 12 mi. below Bodfish; Democrat Springs; Rosedale, 8 mi. W Bakersfield; Cummings Valley, 1½ mi. N Tehachapi, 4,250 ft.; 5½ mi. NW Old Fort Tejon, 1,700 ft.; Old Fort Tejon, 3,200 ft. *San Bernardino County:* Horse Spring, 4,750 ft., Kingston Range; 2 mi. N Horse Spring, Kingston Range; Pachalka Spring, 4,800 ft., Clark Mountain; southeast side Clark Mountain, 5,800 ft. and 7,300 ft.; Cedar Canyon, 5,000 ft., Providence Mountains; 2 mi. ESE Rock Springs, 4,750 ft., Lanfair Valley; Victorville (LAM); Lytle Creek, 14 mi. WNW San Bernardino (SNHM); lower Santa Ana Canyon; Colton (LMK). *Los Angeles County:* Mount Wilson (Nokes). *Riverside County:* Live Oak Canyon, near Redlands (San Bernardino County) (LMK); Covington Flat, 4,500 ft., Joshua Tree National Mounment. *San Diego County:* Upper Doane Valley* (LMK); Mesa Grande (LAM); Warner's Ranch (LAM); San Felipe Valley (LAM); San Pasqual* (LAM); Witch Creek* (CAS); Banner*; Foster (SDSNH); Ramona* (LAM); El Capitan* (LMK); Suncrest* (LMK); Alpine (LMK); Lawson Valley (SDSNH); Deerhorn Flat (SDSNH).

LOWER CALIFORNIA. San Antonio del Mar.

* Localities where *E. skiltonianus* has also been taken.

NEVADA. *Nye County:* 1½ mi. E and 1 mi. S Grapevine Peak, 7,000 ft.; 5 mi. E and 1 mi. S Grapevine Peak, 6,000 ft.

ARIZONA. *Yavapai County:* 5 mi. N Wickenburg; Yarnell.

Eumeces lagunensis Van Denburgh

Eumeces lagunensis Van Denburgh (1895: 79, 134, 135, pl. 13), original description; type locality San Francisquito, Sierra de la Laguna.

Plestiodon lagunensis, Van Denburgh and Slevin (1921: 52).

Eumeces skiltonianus lagunensis, Linsdale (1932: 374).

Range.—Probably the southern one-third of Lower California.

Species characters.—Tail of young salmon color; color pattern, including dorsolateral and lateral lines, retained throughout life. Adults reach maximum size of about 60 mm. Hind leg 34.8 per cent and foreleg 24.2 per cent of snout–vent length; no area of granules in axilla; supralabials 7, nuchals 2 pairs; scales from occiput to base of tail 58–60; interparietal smaller than either frontoparietal and surrounded posteriorly by the parietals; last supralabial broadly in contact with upper secondary temporal.

Comparison with other forms.—Resembles *skiltonianus* in size and color pattern but tail salmon instead of blue. Scales of postlabial and temporal region differ from those of any other form in the *skiltonianus* group.

Remarks.—Although *lagunensis* was originally described as a separate species (Van Denburgh, 1895: 134, 135), its status as such was doubted by its author (Van Denburgh, 1922: 588, 589), and by Loveridge (1930: 111), and it was considered a subspecies of *skiltonianus* by Linsdale (1932: 374). Taylor (1935: 431–437) again recognized it as a distinct species.

In the original description of this form, Van Denburgh gave as diagnostic characters: "Tail salmon color instead of blue, . . . interparietal smaller than either frontoparietal instead of longer." It is probable that the tail color referred to indicates a difference comparable to that between *E. g. gilberti* and *E. g. rubricaudatus* or *E. g. cancellosus.* Van Denburgh also describes "poorly defined lines of slaty heliotrope," on the dorsal surface of the tail, and Taylor (1935: 436) described purplish color on the tip of the regenerated tail of one specimen. This suggests further similarity to the species *gilberti,* where *cancellosus* and *cancellosus-rubricaudatus* or *gilberti-rubricaudatus* intermediates have a wash of blue over the pink. The shape of the interparietal fits into a north-south trend within *skiltonianus* that was described on pages 191, 192. Neither of these characters can be considered good species characters.

Linsdale (1932) recognized the probable distinctness of *lagunensis* but concluded that because the differences appear to be small it should be recognized as a subspecies of *skiltonianus.* However, Taylor (1935: 435–437) points out that the small series of available specimens of *lagunensis* indicate other differences, some of which are certainly valid. Most of his characters have to do with a difference in the shape and relative size of the scales of the side of the head. The most posterior (usually the seventh) supralabial is large in relation to those anterior to it. It has a wider posterior angle which contributes to its broader contact with the upper secondary temporal. The postlabial is relatively large. The primary temporal is small, also contributing to broad contact

between the seventh supralabial and the upper secondary temporal. The upper secondary temporal is relatively large. Also, according to Taylor, *lagunensis* differs from *skiltonianus* in having lower counts in the subdigital formula, no area of granules in the axilla, lower scale count around the body, and somewhat shorter legs. Thus, Taylor's work has indicated that when more specimens are available, we will probably find sufficient difference between *lagunensis* and *skiltonianus* to warrant maintaining *lagunensis* as a separate species.

Locality from which which specimens of E. lagunensis have been examined.—LOWER CALIFORNIA. Commondú.

SUMMARY

The skinks of the Pacific coast of North America consist of three species, *Eumeces skiltonianus*, *E. gilberti*, and *E. lagunensis*. *E. gilberti*, the largest of the three, usually loses its color pattern completely with age, and usually before the lizard has reached the maximum size of the species *skiltonianus*. *E. skiltonianus* does not lose its color pattern at all. Sexual dimorphism is found to exist in degree of loss of color pattern in all four races of *gilberti* (least in race *gilberti*); the females of two of these races (one newly described in this paper) retain some of the color pattern throughout life.

Careful comparisons of the form of the individual units of the color pattern disclose similarity between *E. skiltonianus*, *E. g. gilberti*, and *E. g. placerensis*, these differing from *E. g. cancellosus* and *E. g. rubricaudatus*, which are also much alike. An understanding of the differences in the character of the color pattern has made it possible to determine the relationships of certain individual specimens and small groups of specimens that are too few in number to use in comparisons of scale characters or body proportions, with respect to which only average differences between populations can be recognized.

The tail color of the young of these species may be blue, pink, or pink with a blue wash dorsally. The tails that are pink with a blue wash are found in the area of intergradation between *E. g. gilberti* (a blue-tailed form) and *E. g. rubricaudatus* (a pink-tailed form). They are also found in young of *cancellosus* (a pink-tailed form) and in the population that is intermediate between *cancellosus* and *rubricaudatus*. Older blue-tailed *skiltonianus* may have pink on the ventral surface of the tail, and older *gilberti* (past the blue-tailed stage) may have brick-red tails. The pinkness or redness may develop on the tails of older specimens of either sex.

Adults of *gilberti* and *cancellosus* and of *rubricaudatus* of the desert mountains are known to develop bright red heads, and adults of *skiltonianus* are known to develop bright redness on the upper and lower labials, the chin, and to a lesser extent on the sides of the head. The red of *cancellosus* and *rubricaudatus* is slightly lighter than that of *gilberti*. The most brightly colored red-headed skinks observed were males, although some females also are red-headed and some large adult males are not. The red becomes brighter in the breeding season.

All four races of *E. gilberti* have much greater snout–vent length than does *skiltonianus*. *Cancellosus* is the smallest race of *E. gilberti*, but even so it is

much larger than *E. skiltonianus*. *E. lagunensis* probably averages smaller than *skiltonianus*.

Trends of variation within races in size and retention of color pattern suggest intergradation of *E. skiltonianus* and *E. g. placerensis* on the floor of the Sacramento Valley. However, at present *E. skiltonianus* is not known to inhabit any part of the valley floor. Where the ranges of the two species are known to adjoin (Yuba River and eastern Contra Costa County), they are easily distinguishable and apparently do not interbreed. Where their ranges are known to overlap (San Diego County), they are most strikingly different.

LITERATURE CITED

BAIRD, S. F., and C. GIRARD
1852. Characteristics of some new reptiles in the museum of the Smithsonian Institution. Proc. Acad. Nat. Sci. Phila., 1852: 68–70.

BOCOURT, F.
1879. Recherches zoologiques pour servir a l'histoire de le faune de l'Amérique Centrale et due Mexique; Étudés sur les Reptiles et les Batraciens. Misc. Sci. Mex. et Amér. Cent., III (Paris, 1870), Livraison VI: 361–440, pls. 21–22, 22A, 22B, 22C, 22D.

CAMP, C. L.
1916. The subspecies of *Sceloporus occidentalis* with description of a new form from the Sierra Nevada and systematic notes on other California lizards. Univ. Calif. Publ. Zoöl., 17: 63–74.

COPE, E. D.
1900. Crocodilians, lizards and snakes of North America. Rept. U. S. Nat. Mus., 1898: xi–xviii, 155–1270, pls. 1–36, text figs. 1–347.

DICE, L. R., and H. J. LERAAS
1936. A graphic method for comparing several sets of measurements. Contr. Lab. Vert. Gen., Univ. Mich., No. 3: 1–3, 1 fig.

GRINNELL, J., and C. L. CAMP
1917. A distributional list of the amphibians and reptiles of California. Univ. Calif. Publ. Zoöl., 17: 127–208, 14 figs.

HALLOWELL, E.
1859. Report upon the reptiles collected on the survey. Pacific Railroad Reports, vol. 10, pt. 4, Zoöl. Report, no. 1: 1–27, pls. 1–10.

KLAUBER, L. M.
1939. Studies of reptile life in the arid Southwest. Bull. Zoöl. Soc., San Diego, no. 14: 1–100, 19 tables.

LINSDALE, J. M.
1932. Amphibians and reptiles from Lower California. Univ. Calif. Publ. Zoöl., 38: 345–386.

LOVERIDGE, A.
1930. On some skinks of the genus *Eumeces* from North America. Copeia, 1930: 111–112.

MCCAULEY, R. H., JR.
1939. Differences in the young of *Eumeces fasciatus* and *Eumeces laticeps*. Copeia, 1939: 93–95.

NOBLE, G. K., and E. R. MASON
1933. Experiments on the brooding habits of the lizards *Eumeces* and *Ophisaurus*. Amer. Mus. Novit., no. 619: 1–29, 6 figs.

RIDGWAY, R.
1912. Color standards and color nomenclature. (Washington, D. C.: published by the author), iv + 44 pp., 53 pls.

RODGERS, T. L.
1944. A new skink from the Sierra Nevada of California. Copeia, 1944: 101–104, 2 figs.

RODGERS, T. L., and V. L. MEMMLER
1943. Growth in the western blue-tailed skink. Trans. San Diego Soc. Nat. Hist. 10: 61–68, 1 fig.

TAYLOR, E. H.
1935. A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. Kansas Univ. Sci. Bull., vol. 23 (whole series, vol. 33): 1–643, 84 figs., plus 43 pls.

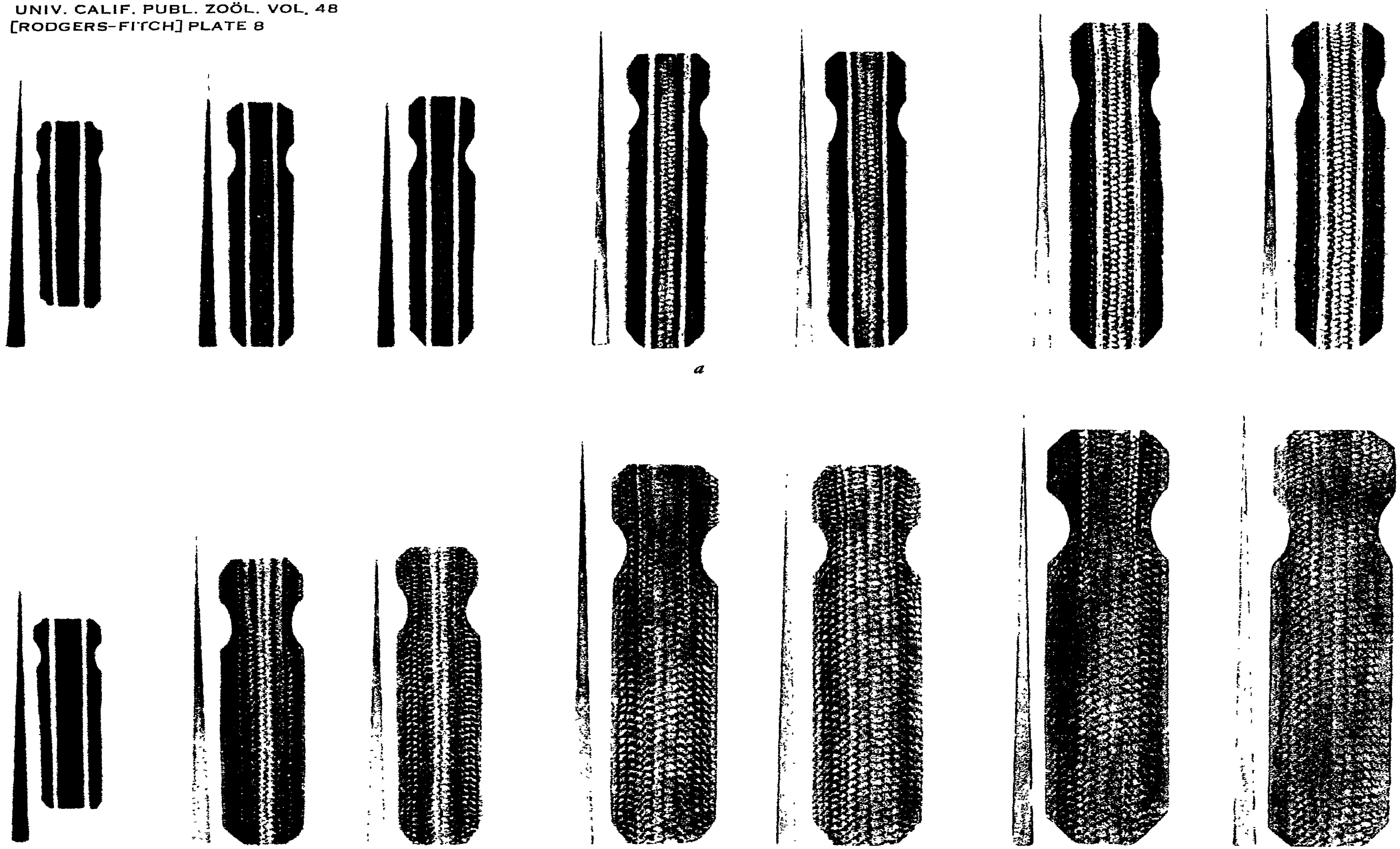
VAN DENBURGH, J.
1895. A review of the herpetology of Lower California. Part I: Reptiles. Proc. Calif. Acad. Sci., ser. 2, 5: 77–162, pls. 6–14.
1896. Description of a new lizard (*Eumeces gilberti*) from the Sierra Nevada of California. Proc. Calif. Acad. Sci., ser. 2, 6: 350–352.

VAN DENBURGH, J., and J. R. SLEVIN
1921. A list of the amphibians and reptiles of the peninsula of Lower California, with notes on the species in the collection of the Academy. Proc. Calif. Acad. Sci., ser. 4, 11: 49–72.

PLATES

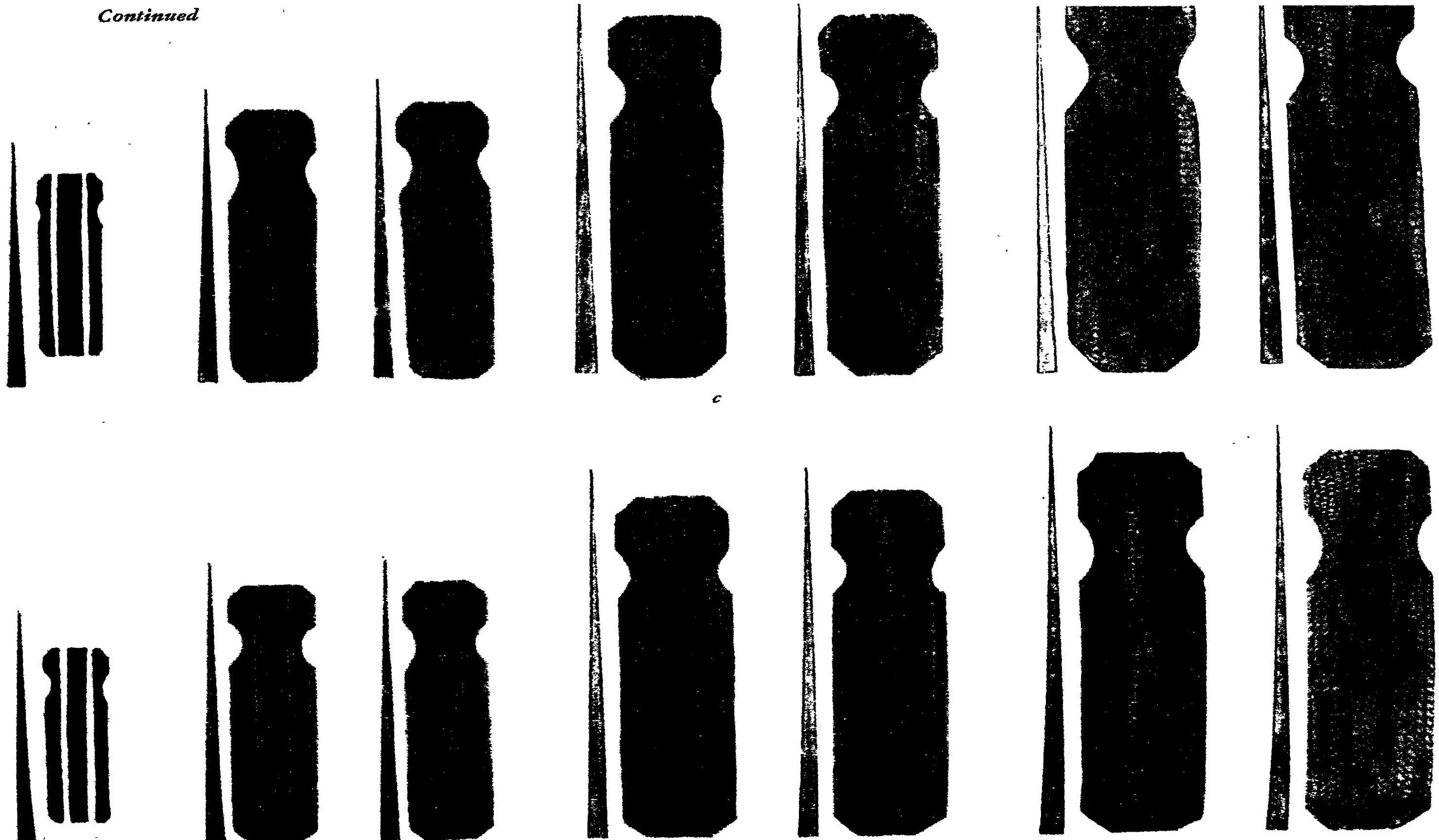
PLATE 8, *a–e*

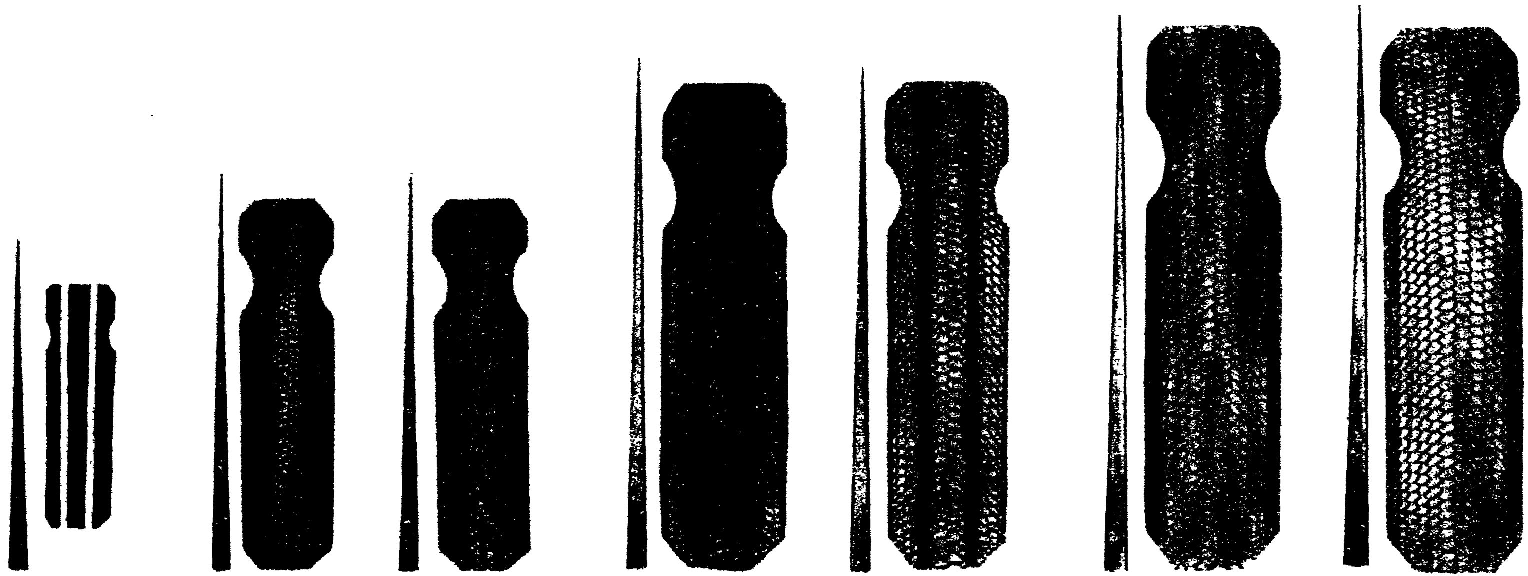
Semidiagrammatic sketches of flattened skin of back and sides of typical specimens of *E. skiltonianus* and the four races of *E. gilberti*, showing differences in form and development of the color pattern and in sexual dimorphism. Tail color shown to left of each sketch. Smallest sketch to the left represents young specimen within a few weeks of hatching; next, large young (female and male), small adult (female and male), and large adult (female and male). In *E. skiltonianus*, these four groups represent typical appearance for less than 1 month, 10 months, 22 months, and 3 or more years of age. In other forms, the ages are not known, but size groups are comparable to age groups in *skiltonianus*. Most sketches were made from individuals chosen as typical; however, it was necessary occasionally to combine the characters of two or more animals. Differences in size between young and adult, and between the different forms are reduced for convenience in illustration.



a

Continued





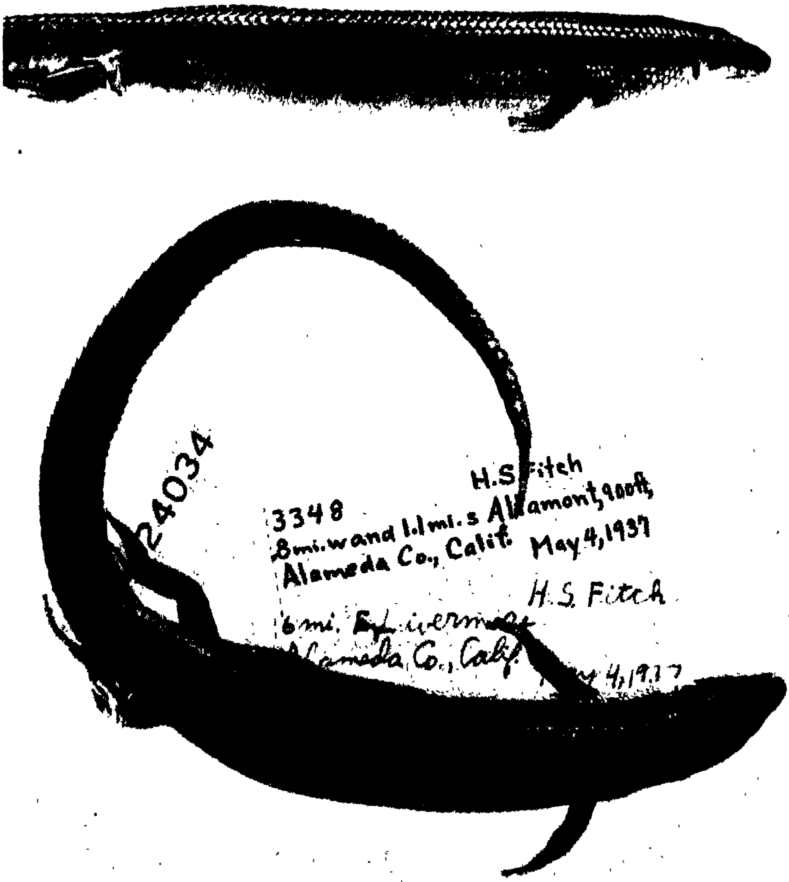
e

c. Eumeces gilberti gilberti. d. Eumeces gilberti cancellosus.
e. Eumeces gilberti rubricaudatus.

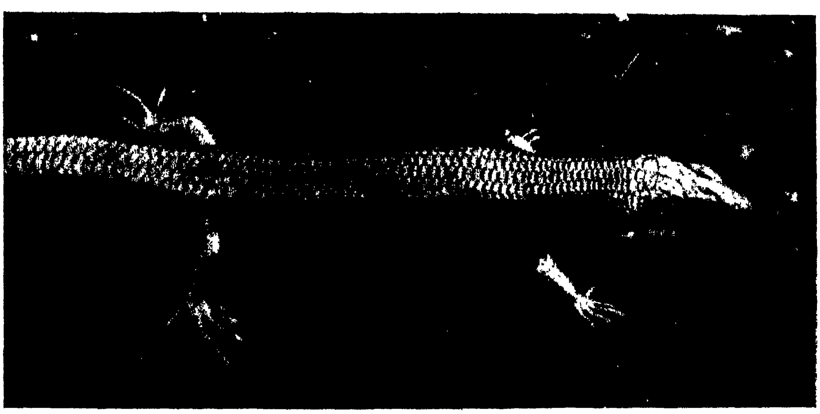
PLATE 9, *a–b*

Fig. *a*. Lateral and dorsal views of type specimen of *Eumeces gilberti cancellosus,* new subspecies. Adult female, no. 24034, Mus. Vert. Zoöl.

Fig. *b*. Dorsolateral view of live specimen of adult male of *Eumeces gilberti cancellosus.*


24034
H.S Fitch
3348
Alameda Co., Calif.
May 4, 1937
H.S. Fitch
Alameda Co., Calif.

a



b

PLATE 10

Type locality of *Eumeces gilberti cancellosus*; 0.8 miles west and 1.1 miles south of Altamont, Alameda County, California, 900 feet. (Photographed April 12, 1943, by C. P. North.)

VERTEBRATE ANIMALS OF THE PROVIDENCE MOUNTAINS AREA OF CALIFORNIA

BY

DAVID H. JOHNSON, MONROE D. BRYANT, AND ALDEN H. MILLER

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1948

University of California Publications in Zoölogy
Editors (Berkeley): Harold Kirby, Jr., R. M. Eakin, S. F. Light, A. H. Miller

Volume 48, No. 5, pp. 221-376, 52 figures in text, 1 map
Submitted by editors September 24, 1947
Issued August, 20 1948
Price, $2.50

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

VERTEBRATE ANIMALS OF THE PROVIDENCE MOUNTAINS AREA OF CALIFORNIA

BY

DAVID H. JOHNSON, MONROE D. BRYANT, AND ALDEN H. MILLER

(Contribution from the Museum of Vertebrate Zoölogy of the University of California)

INTRODUCTION

WITH THE ESTABLISHMENT of the Museum of Vertebrate Zoölogy in 1908, the institution embarked upon a program designed to afford a thorough knowledge of the vertebrate animals of California and to provide information on the factors involved in their distribution and on their relationships to adjoining vertebrate faunas. Accordingly, the following areas in southern California have been studied (fig. 1): San Bernardino Mountains (Grinnell, 1908), San Jacinto

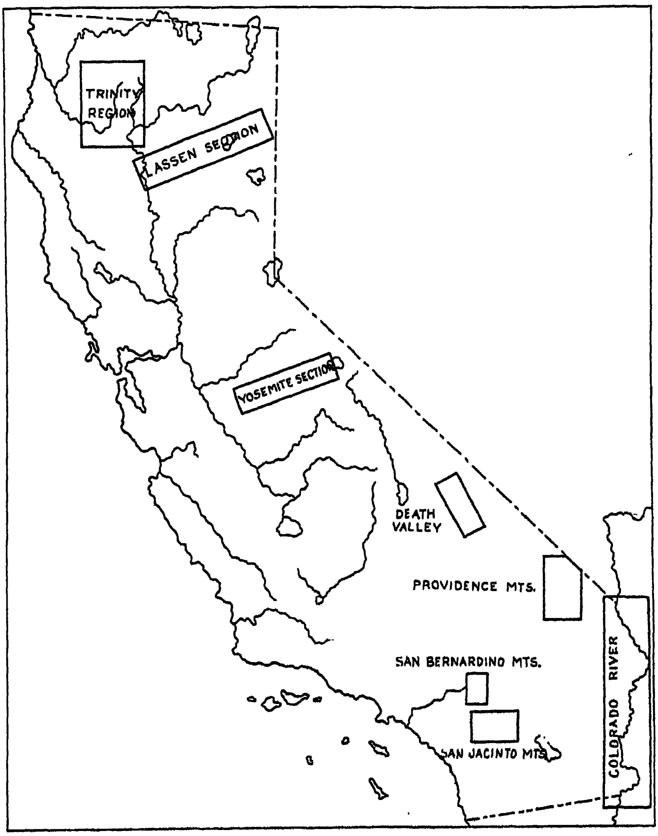


FIG. 1. Map of California showing position of Providence Mountains area and locations of other areas which have been surveyed in a similar manner under the auspices of the Museum of Vertebrate Zoölogy.

Mountains (Grinnell and Swarth, 1913), lower Colorado River valley (Grinnell, 1914), and Death Valley (Grinnell, 1923*a*, 1934, 1937; Miller, 1946). The present report is correlated with these earlier investigations and has as its main

purpose the determination of the systematic status and faunal and ecologic relationships of the vertebrates of a section of eastern San Bernardino County, California, in the Mohave Desert, of which part the Providence Mountains are the most conspicuous feature. In the work toward the achievement of these aims, much information on the natural history of the vertebrate animals has been obtained and is included in the accounts of the species.

The field work upon which our report is based began on a small scale in 1917. In March of that year, Joseph Grinnell drove through parts of the area and returned in company with F. B. Sumner in 1920 to camps at the Pumping Station, three miles north of Ivanpah (see description of localities, pp. 248–255), on April 24, and at Purdy on April 25 and 26.

Miss Annie M. Alexander and Miss Louise Kellogg collected in the pass between the Granite and Providence mountains from December 9 to 11, 1937, and in the area five miles north of Kelso Peak on December 12 and 13.

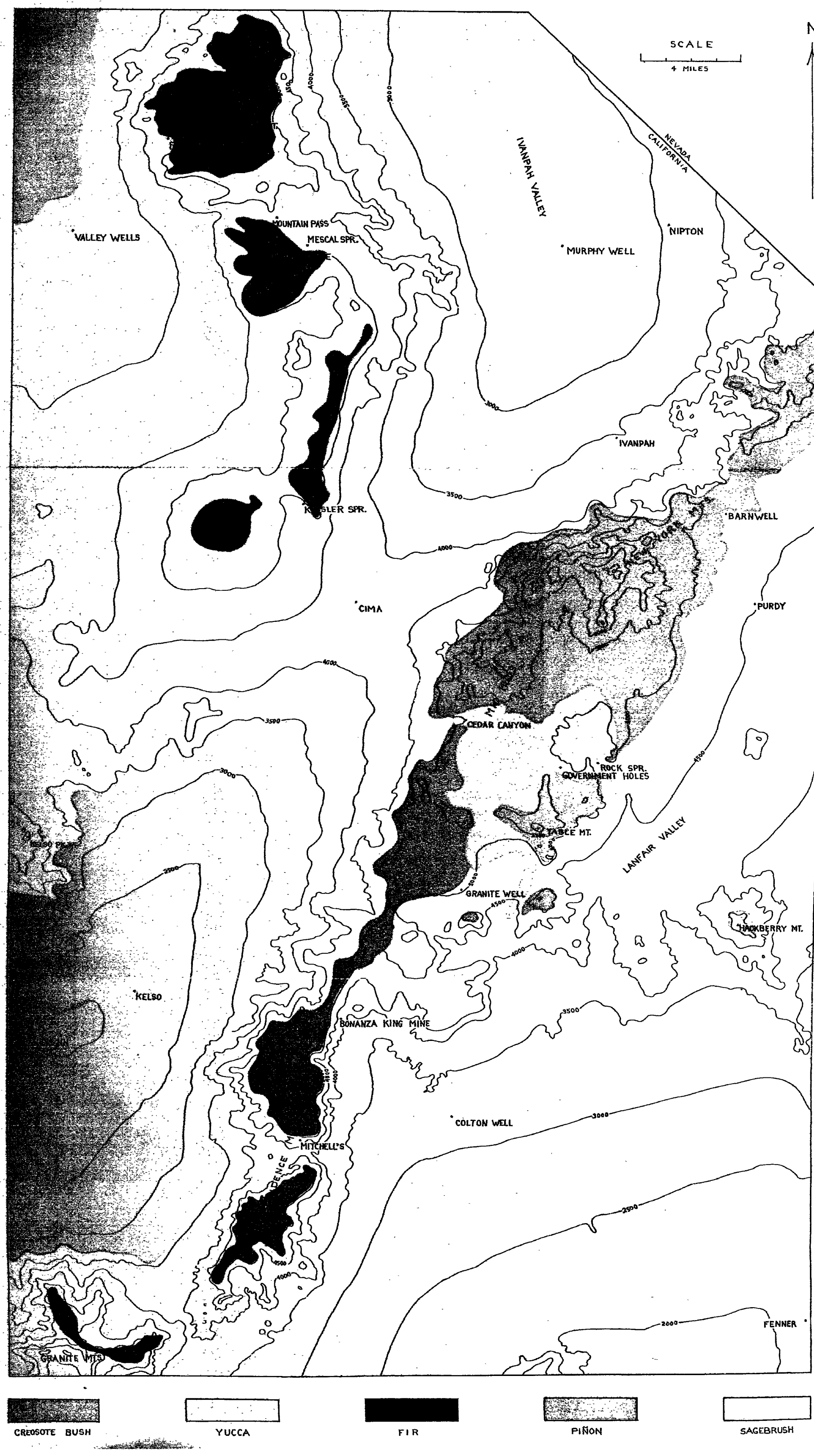
A party composed of David H. Johnson, Dale Arvey, Floyd Durham, Joe T. Marshall, Jr., and Wallace Taber worked in the vicinity of the Providence Mountains from December 17, 1937, to January 13, 1938. Their camps were: six miles south of Granite Well, December 17 to 25; Mitchell's, December 25 to 27; five miles northeast of Granite Well, December 27 to January 6; Cedar Canyon, January 6 to 8; and three miles north of Cima, January 8 to 13. Studies were made at the following places in addition to those in the vicinity of the camps: Granite Well, five miles southeast of Cima, seven miles north of Essex, and Rock Spring.

Joseph Grinnell, David H. Johnson, Elmer C. Aldrich, Dale Arvey, and Thomas L. Rodgers worked in the area in May and June of 1938. Camps were established at the following places: two miles north-northeast of Cima, May 13 to 19; Cedar Canyon, May 19 to June 4; two miles east-southeast of Rock Spring, June 4 to 6; Colton Well, June 6 to 8; Mitchell's, June 8 to 10; and the pass between the Granite and Providence mountains, June 10 to 11. Other areas studied at this time were: five miles southwest of Ivanpah, Mescal Cave, five miles southeast of Cima, Government Holes, Lanfair Valley, Purdy, Ivanpah, Nipton, and Cima.

Alden H. Miller, Ward C. Russell, M. D. Bryant, A. Starker Leopold, and Ronald W. Smith collected in the northern part of the area from May 16 to June 1, 1939. Camps were made as follows: southeast side of Clark Mountain, May 16 to 23; north side of Clark Mountain, May 23 to 29; Mescal Spring, May 29 to 31; and Pachalka Spring, May 31 to June 1. The valley west of Clark Mountain also was studied at this time.

David H. Johnson, Harvey I. Fisher, and Milton Hildebrand worked in the area from June 18 to 26, 1940, and made camps as follows: two and one-half miles southwest of Kelso, June 18 to 23, and the pass between the Granite and Providence mountains, June 23 to 26. Studies were also conducted at Mitchell's and at Cima.

M. D. Bryant and Ward C. Russell made a general survey of the area from October 1 to 7, 1945. Camps were established: Pachalka Spring, October 2 and 3; Mescal Spring, October 3 and 4; Cima, October 4 and 5; and Colton Well,


N
SCALE
4 MILES
NEVADA
CALIFORNIA
IVANPAH VALLEY
MOUNTAIN PASS
MESCAL SPR.
VALLEY WELLS
NIPTON
MURPHY WELL
IVANPAH
BARNWELL
PURDY
CIMA
CEDAR CANYON
ROCK SPR.
GOVERNMENT HOLES
LANFAIR VALLEY
GRANITE WELL
HACKBERRY MT.
KELSO
BONANZA KING MINE
COLTON WELL
MITCHELL'S
GRANITE MTS.
FENNER
3000
3500
4000
4500
2500
2000
CREOSOTE BUSH
YUCCA
FIR
PIÑON
SAGEBRUSH

October 5 to 7. Other places visited at this time were the valley west of Clark Mountain, the north, east, and south sides and summit of Clark Mountain, Mescal Cave, Ivanpah Valley, Ivanpah, Mitchell's, Essex Plain, Lanfair Valley, Rock Spring, Cedar Canyon, the sand dunes southwest of Kelso, and the pass between the Granite and Providence mountains.

The field work carried on by the Museum of Vertebrate Zoölogy thus extended from 1917 to 1945, with the major part in 1938, 1939, and 1940. Eighteen people spent 367 man-days in the area. We collected 69 specimens of amphibians, 600 of reptiles, 896 of birds, and 1,017 of mammals. Thorough notes taken throughout the course of study have contributed greatly toward the completeness of the present account.

Ned Hollister collected mammals and birds at Ivanpah from June 1 to 5, 1905, and in the New York Mountains, twelve miles south of Ivanpah, from June 8 to 10 of the same year. We have examined his field notes and the specimens that he collected.

As regards the authorship of this paper, Dr. Johnson in 1940 and 1941 did the major work of compiling the mass of field data and of identifying specimens. In 1945 Dr. Bryant completed the accounts of mammals and prepared the section on plant belts, habitats, and localities. Dr. Miller participated in the identification of species, particularly of birds, revised nomenclature to 1947, and made an analysis of the fauna.

The entire undertaking in the Providence Mountains area has received generous support from Annie M. Alexander whose helpful understanding of the problems entailed and whose provision for field and museum work is most gratefully acknowledged. The photographs in the report were taken by Elmer C. Aldrich while with our field party in the spring of 1938. We are indebted to Dr. Herbert L. Mason of the Herbarium of the University of California for identification of our collection of plants from the area.

PHYSIOGRAPHY

The geographic area included in our report lies in the eastern part of San Bernardino County, California (fig. 1). It is bounded on the north by latitude 35° 36′, on the northeast by the California-Nevada boundary, on the east by longitude 115° 10′, on the south by latitude 34° 47′, and on the west by longitude 115° 44′ (fig. 2). There are approximately 1,770 square miles in the area. The greatest east-west dimension is 33 miles; the length is 56 miles.

Two main groups of mountains dominate the area under consideration. The northern group runs in a north-south direction and comprises Clark Mountain, the Mescal Range, and the Ivanpah Mountains. It is connected by lower mountains with the Kingston Range to the northwest and with the Charleston Mountains of Nevada to the north. The lowest points in these connecting mountains are 3,600 feet and 3,700 feet in elevation, respectively. The land slopes gradually eastward from the bases of this group to Ivanpah Valley and westward to the valley in which Valley Wells is situated (figs. 6 and 3). The other group of mountains runs in a northeast-southwest direction and includes

Facing. Fig. 2, map of Providence Mountains area, California, eastern San Bernardino County, showing plant belts and principal localities. Contour interval, 500 feet.

the New York Mountains, Mid Hills, the Providence Mountains, and the Granite Mountains (figs. 2, 4, 5, and 15). This group is continuous with the McCullough Range of Nevada. The land northwest of the group is gently sloping, as it is on the southeast side, except in the Mid Hills section. In this section several spurs run from the main range toward the east to isolate several small valleys, and one low series of mountains continues eastward to join Hackberry Mountain to the group. This low series separates Lanfair Valley (a plateau) from the Essex-Fenner plain. The two main groups of

FIG. 3. Clark Mountain viewed from the west near Valley Wells. Pachalka Spring is situated in the foothills. Photograph taken May 30, 1938.

mountains are separated by the Cima plateau (fig. 2), which is about eight miles wide and has a minimum elevation of about 4,000 feet.

The area is separated, except on the north, from other mountainous areas by valleys which are less than 2,000 feet in elevation and which are, for the most part, less than 1,000 feet. The valley of the Colorado River lies to the east, Death Valley lies north and west, and the valley in which the dry beds of Bristol, Cadiz, and Danby lakes occur lies to the south. Elevations within the area vary from about 1,800 feet near Essex and Flynn to 7,903 feet on the summit of Clark Mountain.

The upper parts of the mountains are in general precipitous and are cut by numerous steep-sided ravines. The more gradual slopes of their bases begin at an altitude of about 5,000 feet, and the gradient becomes progressively less toward the surrounding lowlands.

There are no permanent streams in the area. Snow or rainfall suffices to maintain many springs and wells throughout the year. Some 50 springs are

FIG. 4. Town of Barnwell in flat, with New York Mountains in background. Small Joshua trees and Spanish bayonet in foreground. Photograph taken May 30, 1938.

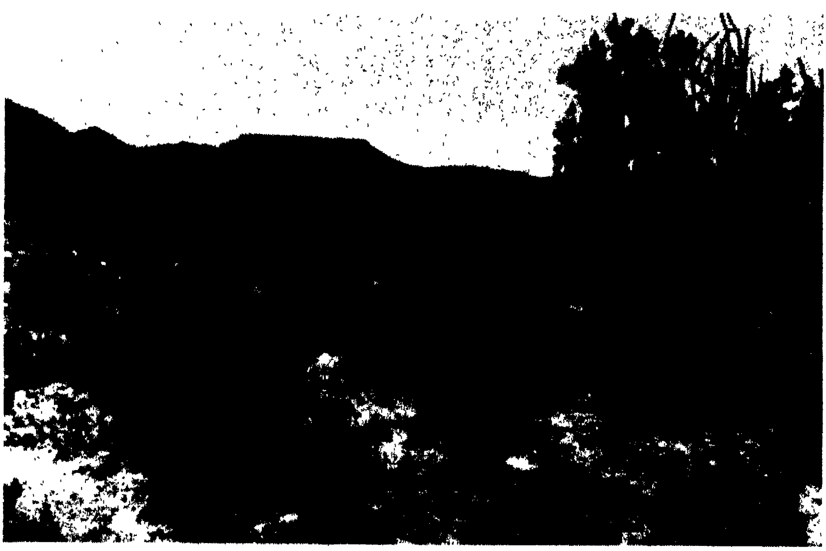


FIG. 5. View southeastward toward Table Mountain showing sagebrush and junipers. Table Mountain lies east of Cedar Canyon and the Mid Hills section. Photograph taken May 27, 1938.

distributed about the bases of the mountains between elevations of 3,700 and 5,700 feet, most of them between the 4,700 and 5,300 foot contours. The wells dug to supply water for the villages and ranches are widely used by the birds and mammals of the area.

PLANT BELTS

As one travels from the lower elevations toward the mountains in that part of the Mohave Desert under consideration, certain changes in the vegetation are apparent. There is a belt in the lower and usually flatter parts of the area in which the creosote bush is the most conspicuous plant (fig. 6). The creosote

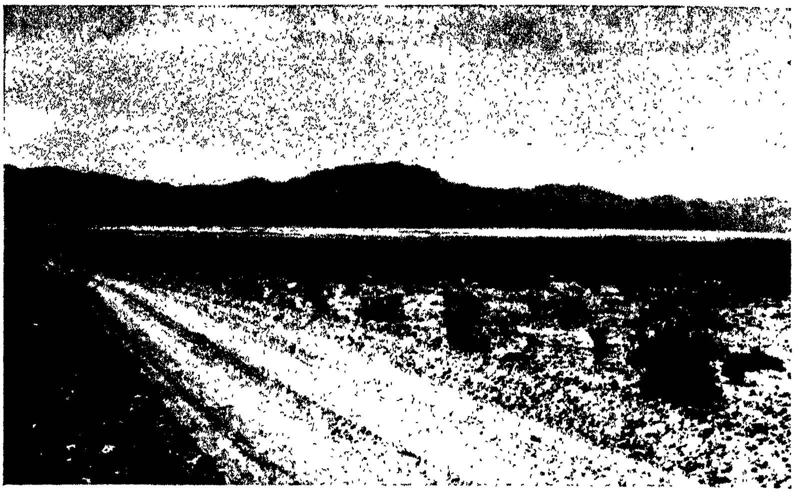


FIG. 6. Creosote bush belt in Ivanpah Valley at 3,700 feet. View across dry lake bed toward Clark Mountain. Photograph taken May 30, 1938.

FIG. 7. Joshua tree woodland of maximum development in yucca belt near Kessler Spring, 4,200 feet, 4 miles north of Cima. Nesting habitat of Costa Hummingbird. Photograph taken May 17, 1938.

FIG. 8. Vegetation of yucca belt 2 miles north-northeast of Cima, 4,100 feet. Joshua trees, Spanish dagger, and ephedra are common here. Loggerhead shrikes, black-throated sparrows, mockingbirds, ground utas, whip-tailed lizards, and desert wood rats occurred here. Photograph taken May 16, 1938.

FIG. 9. Sagebrush belt at Government Holes. Sagebrush and purshia are prominent in foreground. Junipers and piñons appear on rocky slope on left. Blue-gray gnatcatchers, crissal thrashers, western kingbirds, whip-tailed lizards, and Audubon cottontails occurred here. Photograph taken May 27, 1938.

bush decreases in abundance with decreasing distance from the mountains, and the yuccas (Joshua tree, Spanish dagger, and Spanish bayonet) correspondingly increase (figs. 7 and 8). On gradual slopes the areas of blending (ecotones) of the creosote bush and yuccas are extensive. Tongues of junipers extend down the ridges at the bases of the higher mountains into the yucca belt and in the mountains the junipers blend with the piñons to form a woodland belt (fig. 11). These three vegetative types, creosote bush, yucca, and piñon-juniper, are present throughout the area at their respective levels. In addition, two other vegetative types are present. These are characterized by sagebrush and white fir and do not form bands. The fir forest is restricted to the north side of Clark Mountain and would undoubtedly form a belt if the mountains of the area were higher. Sagebrush is present throughout the area above the yucca belt, but it is present as a dominant plant only on the southeast side of the central part of the Providence–New York Range (fig. 9).

For our purposes it appears best to classify the vegetational types, or belts, as follows: creosote bush, yucca, sagebrush, piñon, and white fir. In view of the lack of a clear-cut boundary between the creosote bush and yucca belts, it might seem reasonable to place them as subdivisions of a larger unit called desert scrub, which would be comparable to the other belts but less uniform in character. On the other hand the physical aspect of the yucca growth, especially the Joshua tree, relates it somewhat to woodland rather than to desert scrub formation. To our knowledge these vegetational types have not been altered by fire, grazing, or lumbering, and we assume that they are the climax types.

The position of the plant belts recognized by us in relation to larger associational categories is shown in table 1. The life-zones are based on the interpretations of Merriam (1898), Hall and Grinnell (1919), and others. The formations and associations are those of Weaver and Clements (1938), and the vegetational areas are as proposed by Livingston and Shreve (1921).

TABLE 1

RELATIONS OF LARGER ASSOCIATIONAL CATEGORIES IN PROVIDENCE MOUNTAINS AREA

Belt	Life-zone	Formation and association	Vegetational area
Creosote bush, Yucca	Lower Sonoran	Desert scrub formation and association	California microphyll desert
Sagebrush	Upper Sonoran	Sagebrush formation, Basin sagebrush association	Great Basin microphyll desert
Piñon	Upper Sonoran	Woodland formation, piñon-juniper association	Western xerophytic evergreen forest
White fir	Transition	Montane forest formation, petran montane forest association	Northern mesophytic evergreen forest

The lists which follow show the plant belts in which many of the vertebrates of the area occur. Reference to the correlation table will enable the reader to determine the zonal positions of the reptiles, birds, and mammals. For species of birds not permanently resident seasonal occurrence is indicated; species occurring solely as migrants in passage are not listed. Lack of information prohibits the inclusion of some species in the lists. When a species of vertebrate occurred in two or more belts, but more abundantly in one, the name of the belt in which it was most in evidence is placed in parentheses after the name of the species. It should be recognized that at other geographic localities some species are known to occur in belts or zones other than those indicated here. Indeed we may have failed in some instances to discover the full range of occurrence within the area studied. In other instances the secondary zonal occurrences in this area may not represent the norm for these species or races throughout their ranges.

CREOSOTE BUSH BELT

Dipsosaurus dorsalis dorsalis
Uma scoparia
Urosaurus graciosus
Crotalus cerastes cerastes
Speotyto cunicularia hypugaea
Auriparus flaviceps acaciarum
Toxostoma lecontei lecontei
Citellus tereticaudus tereticaudus
Dipodomys deserti deserti

YUCCA BELT

Coleonyx variegatus variegatus
Crotaphytus collaris baileyi
Xantusia vigilis
Pituophis catenifer deserticola
Crotalus scutulatus
Crotalus mitchellii pyrrhus
Buteo swainsoni [summer]
Colaptes chrysoides mearnsi
Dendrocopos scalaris cactophilus
Campylorhynchus brunneicapillus couesi
Toxostoma bendirei [summer]
Sialia mexicana bairdi [winter]
Sialia currucoides [winter]
Icterus cucullatus californicus [summer]
Dipodomys microps occidentalis(?)

SAGEBRUSH BELT

Reithrodontomys megalotis megalotis (?)

PIÑON BELT

Sceloporus occidentalis biseriatus
Coluber taeniatus taeniatus
Accipiter cooperii
Otus asio cineraceus
Selasphorus platycercus platycercus [summer]
Asyndesmus lewis [winter]
Sphyrapicus thyroideus nataliae [winter]
Tyrannus vociferans vociferans [summer]
Parus inornatus ridgwayi
Sitta canadensis [winter]
Hylocichla guttata guttata [winter]
Myadestes townsendi townsendi [winter]
Dendroica nigrescens [summer]
Pheucticus melanocephalus melanocephalus [summer]
Loxia curvirostra grinnelli [summer]
Loxia curvirostra benti [nonbreeding]
Chlorura chlorura [summer]
Junco hyemalis hyemalis [winter]
Junco hyemalis cismontanus [winter]
Junco oreganus montanus [winter]
Junco oreganus oreganus [winter]
Junco oreganus shufeldti [winter]
Eutamias panamintinus panamintinus
Erethizon epixanthum
Ovis canadensis nelsoni

WHITE FIR BELT

The patches of white firs were small and few vertebrates were actually restricted to them; the firs were entered casually by a number of species inhabiting the surrounding piñon belt. We list here only those vertebrates which appeared to depend on the firs for their presence in the area.

Otus flammeolus [summer]
Dendrocopos villosus
Parus gambeli inyoensis
Hylocichla guttata polionota [summer]
Sialia mexicana bairdi [summer]
Vermivora virginiae [summer]
Spinus pinus pinus [summer]
Junco caniceps caniceps [summer]

CREOSOTE BUSH AND YUCCA BELTS

Gambelia wislizenii wislizenii (yucca)
Sauromalus obesus
Callisaurus dracanoides gabbii (creosote bush)
Sceloporus magister (yucca)
Phrynosoma platyrhinos platyrhinos
Coluber flagellum frenatum
Salvadora hexalepis hexalepis
Lophortyx gambelii gambelii (yucca)
Zenaidura macroura marginella [summer]
Geococcyx californianus (yucca)
Chordeiles acutipennis texensis [summer]
Eremophila alpestris lamprochroma [winter]
Eremophila alpestris ammophila [winter]
Eremophila alpestris leucansiptila
Corvus corax sinuatus
Mimus polyglottos leucopterus (yucca)
Phainopepla nitens lepida (creosote bush)
Lanius ludovicianus nevadensis (yucca)
Lanius ludovicianus gambeli (yucca) [winter]
Vulpes macrotis arsipus
Thomomys bottae providentialis (yucca)
Dipodomys merriami merriami (creosote bush)

CREOSOTE BUSH, YUCCA, AND SAGEBRUSH BELTS

Sayornis saya saya
Amphispiza bilineata deserticola
Amphispiza belli nevadensis [winter]
Perognathus longimembris longimembris
Peromyscus eremicus eremicus (yucca)
Sylvilagus audubonii arizonae (yucca)

YUCCA AND SAGEBRUSH BELTS

Tyrannus verticalis (yucca) [summer]
Toxostoma dorsale dorsale (sagebrush)
Spizella breweri breweri (sagebrush)
Dipodomys panamintinus caudatus
Onochomys torridus pulcher (yucca)
Peromyscus maniculatus sonoriensis (sagebrush)

YUCCA AND PIÑON BELTS

Eumeces gilberti rubricaudatus
Falco sparverius sparverius (yucca)
Otus asio gilmani
Phalaenoptilus nuttallii nuttallii [summer]
Aëronautes saxatalis saxatalis (piñon) [summer]
Tachycineta thalassina lepida (piñon) [summer]
Catherpes mexicanus conspersus (piñon)
Molothrus ater obscurus [summer]
Spinus psaltria hesperophilus (yucca)
Pipilo maculatus montanus (piñon)
Bassariscus astutus
Lynx rufus baileyi
Perognathus formosus mohavensis (yucca)
Urocyon cinereoargenteus scottii (piñon)
Citellus variegatus grammurus

YUCCA, SAGEBRUSH, AND PIÑON BELTS

Aphelocoma coerulescens nevadae (piñon)
Gymnorhinus cyanocephalus (piñon)
Thryomanes bewickii eremophilus (piñon)
Polioptila caerulea amoenissima (piñon) [summer]
Spilogale gracilis gracilis
Peromyscus truei truei (piñon)

SAGEBRUSH AND PIÑON BELTS

Colaptes cafer collaris (piñon) [winter]
Psaltriparus minimus providentialis (piñon)
Regulus calendula cineraceus (piñon) [winter]
Vireo vicinior (sagebrush) [summer]
Carpodacus cassinii [winter]
Spizella atrogularis evura (sagebrush) [summer]
Zonotrichia leucophrys gambelii [winter]

CREOSOTE BUSH, YUCCA, SAGEBRUSH, AND PIÑON BELTS

Uta stansburiana stejnegeri (yucca)
Cnemidophorus tesselatus tesselatus (yucca)
Gopherus agassizii (creosote bush)
Cathartes aura teter [summer]
Buteo jamaicensis calurus
Aquila chrysaëtos canadensis
Falco mexicanus
Bubo virginianus pallescens
Calypte costae (yucca) [summer]
Myiarchus cinerascens cinerascens [summer]
Salpinctes obsoletus obsoletus
Icterus parisorum (yucca) [summer]
Carpodacus mexicanus frontalis
Pipistrellus hesperus hesperus
Taxidea taxus berlandieri (yucca)
Canis latrans estor
Ammospermophilus leucurus leucurus (yucca)
Peromyscus crinitus stephensi (yucca)
Neotoma lepida lepida (yucca)
Lepus californicus deserticola (yucca)

HABITATS

Temperature, moisture, and other features of climate, and historical factors probably account for the presence and position of the plant belts in the area. These with additional factors such as the kind and texture of soil, drainage, erosion, springs, and changes induced by man have resulted in the formation of environmental complexes within the belts which are designated as habitats. One of these habitats predominates in each belt and gives it its name, yet ecologically such a habitat is more narrowly and precisely defined than the belt. When a purely physical aspect of a habitat is the one of primary importance, then the habitat may occur in more than one plant belt.

Sand Dune Habitat.—Large deposits of wind-blown sand are present in the creosote belt southwest of Kelso. These deposits cover an area of several square miles and in some instances rise over 400 feet above the level of the surrounding flats. Small patches of wind-blown sand also occur in the floor of the valley situated west of Clark Mountain and in Ivanpah Valley. Grasses and creosote bushes grow sparingly on the dunes and more abundantly in the shallower sands near their edges.

Uma scoparia and *Dipodomys deserti deserti* were restricted in their distribution to the sand dune habitat, and *Citellus tereticaudus tereticaudus* occurred in greater numbers here than elsewhere in the area. The only family of *Speotyto cunicularia hypugaea* that we found was on the edge of the dunes. It appears that these animals are restricted to or occur most abundantly in the wind-blown sand because of their burrowing tendencies and not because of other requirements. *Dipodomys merriami merriami* was common in the sand dunes. *Lepus californicus deserticola* and *Canis latrans estor* were often present there.

Creosote Bush Habitat.—This habitat extends from the lowest parts of the area at an altitude of about 1,800 feet to about 3,300 feet. Widely spaced creosote bushes are the most conspicuous plants (fig. 6), but with them are many other xerophilous plants such as burrow weed and cholla. Spanish dagger, Spanish bayonet, and Joshua trees (fig. 3) occur at wide intervals in parts of the habitat. The soil may be sandy, gravelly, pebbly, or stony. The rocks often form a desert pavement. The terrain is mostly flat or gently sloping. There is a wide overlapping of the creosote bush and yucca habitats in most places, and the dividing line between them often can be only arbitrary.

Many reptiles, birds, and mammals occurred in this habitat but few of them found their optimum conditions here, and none was restricted to it. *Dipsosaurus dorsalis dorsalis*, *Crotalus cerastes cerastes*, *Gopherus agassizii*, and *Dipodomys merriami merriami* were more abundant in this habitat than in the other habitats.

Yucca Habitat.—The three yuccas that characterize this habitat are the Joshua tree, Spanish dagger, and Spanish bayonet. They are present in small numbers in the creosote bush habitat but are the most conspicuous plants in the belt between the 3,300 foot contour and the piñon belt. Spanish dagger and bayonet grow equally well on the gently sloping mesas (figs. 7 and 8) or in the rough terrain near the bases of the mountains (fig. 25). Joshua trees reach

their maximum development in this region on the Cima plain (fig. 7) and in Lanfair Valley; they are absent from the yucca belt south and east of the Providence Mountains and south of the hills that extend from the main range to Hackberry Mountain, and in other local areas. Several kinds of cacti including *Opuntia basilaris*, *Opuntia ramosissima* (fig. 39), *Opuntia bigelovii* and *Cereus mojavensis*, are abundant in the yucca habitat and constitute an important factor in determining the presence or absence of animals. Sandy washes are present in the flat parts of the habitat (fig. 12), and the ridges near the bases of the mountains interdigitate with the desert washes. The alluvial fans at the mouths of the desert washes are a part of the yucca habitat. More grass is present in this habitat than in any other part of the area. Consequently, most of the ranches are established here and the changes resulting from man's presence are more noticeable.

The following vertebrates were apparently restricted to the yucca habitat in the Providence Mountains region: *Coleonyx variegatus variegatus*, *Xantusia vigilis*, *Crotalus scutulatus*, *Colaptes chrysoides mearnsi*, *Campylorhynchus brunneicapillus couesi*, and *Toxostoma bendirei*. The following species were present in their greatest numbers in this habitat: *Gambelia wislizenii wislizenii*, *Uta stansburiana stejnegeri*, *Cnemidophorus tesselatus tesselatus*, *Falco sparverius sparverius*, *Geococcyx californianus*, *Calypte costae*, *Dendrocopos scalaris cactophilus*, *Tyrannus verticalis*, *Mimus polyglottos leucopterus*, *Lanius ludovicianus nevadensis*, *Lanius ludovicianus gambeli* [winter], *Icterus parisorum*, *Taxidea taxus berlandieri*, *Thomomys bottae providentialis*, *Onychomys torridus pulcher*, and *Neotoma lepida lepida*. *Sceloporus magister* was about equally abundant in the yucca and rock land habitats. Similarly, *Dipodomys panamintinus caudatus* occurred in the yucca and sagebrush habitats.

Sagebrush Habitat.—Sagebrush is present on all of the mountains of the region but it is the dominant plant only in the area east of Cedar Canyon. Junipers and *Purshia* are scattered through the fairly continuous sagebrush cover (figs. 5 and 9). In Cedar Canyon the characteristic plants of the sagebrush, yucca, and piñon habitats are intermixed (fig. 16).

Species more abundant in the sagebrush habitat than in other habitats were *Toxostoma dorsale dorsale*, *Vireo vicinior*, *Spizella breweri breweri*, *Spizella atrogularis evura*, *Reithrodontomys megalotis megalotis*, and *Peromyscus maniculatus sonoriensis*.

Piñon Habitat.—The larger mountains are covered with a scattered or open woodland of piñons (figs. 9, 10, 11, 15 and 16) above an altitude of about 5,300 feet, although the altitude varies with slope exposure and local topography. Junipers are numerous in the habitat, often extending down the ridges below the level of piñon growth.

Coluber taeniatus taeniatus, *Otus asio cineraceus*, *Asyndesmus lewis* [winter] *Sphyrapicus thyroideus nataliae* [winter], *Tyrannus vociferans vociferans*, *Parus inornatus ridgwayi*, *Dendroica nigrescens*, *Loxia curvirostra grinnelli*, *Loxia curvirostra benti* [nonbreeding], *Junco hyemalis hyemalis* [winter], *Junco hyemalis cismontanus* [winter], *Junco oreganus montanus* [winter], *Junco oreganus oreganus* [winter], *Junco oreganus shufeldti* [winter], *Eutamias pana-*

Fig. 10. Junction of sagebrush and piñon belts in Cedar Canyon. Black-chinned and black-throated sparrows occurred in the sagebrush and purshia, bush-tits and blue-gray gnatcatchers in the piñons, and rock wrens and rock squirrels in the rock land habitat of upper slopes. Photograph taken May 28, 1938.

Fig. 11. Piñon belt on hills adjoining a desert wash with growth of desert willow, at 5,000 feet in Cedar Canyon. In this wash cedar waxwings, black-headed grosbeaks, hooded orioles, and ladder-backed woodpeckers frequented the "willows," and Gambel quail and mourning doves, the ground beneath. Photograph taken May 26, 1938.

mintinus panamintinus, and *Erethizon epixanthum* were restricted to the piñon habitat. The following species were more abundant in the piñon habitat than elsewhere: *Accipiter cooperii*, *Colaptes cafer collaris* [winter], *Gymnorhinus cyanocephalus*, *Psaltriparus minimus providentialis*, *Polioptila caerulea amoenissima*, *Regulus calendula cineraceus* [winter], *Peromyscus truei truei*, and *Ovis canadensis nelsoni*.

White Fir Habitat.—Several small, open patches of white firs are present on the north side of Clark Mountain at elevations between 7,000 and 7,500 feet. *Ribes cereum*, *Amelanchier alnifolia*, *Symphoricarpos longiflorus*, and *Heuchera rubescens* are present in the understory. The vegetation of the piñon belt is

FIG. 12. Sandy wash in yucca belt near Cima. This particular section of wash lacks some of the typical plants such as catclaw and desert willow and is bordered in part by Joshua trees and ephedra. Silky pocket mice, Merriam kangaroo rats and southern grasshopper mice were taken here.

mixed with that of the fir forest. The characteristic vertebrates of the area are the same as those listed for the white fir belt on page 229.

Desert Wash Habitat.—This habitat is found in the creosote bush and yucca belts. The desert washes typically have a sandy or gravelly floor in or on the margins of which catclaw, mesquite, and desert willow grow (figs. 11 and 12). In Cedar Canyon and some other areas rabbit brush is a constituent. The washes in the floors of the valleys are in the creosote belt and are usually shallow. In the foothills they are in the yucca belt and are often deep, with their margins consisting either of yucca or rock land habitats. Some of the plants characteristic of the surrounding habitats are usually intermingled with those of the desert washes. The upper ends of the washes usually stop at the bases of the mountains, but in places where broad valleys continue into the mountains the washes may extend above the lower level of the piñon belt.

Urosaurus graciosus, *Auriparus flaviceps acaciarum*, and *Icterus cucullatus californicus* were found only in the desert washes in the course of our work; they are not to be regarded as thus strictly limited in general. The following

vertebrates attained their maximum numbers in this habitat but were also found in other habitats: *Callisaurus draconoides gabbii*, *Lophortyx gambelii gambelii*, *Zenaidura macroura marginella*, *Toxostoma lecontei lecontei*, *Vulpes macrotis arsipus*, *Lynx rufus baileyi*, *Ammospermophilus leucurus leucurus*, *Peromyscus eremicus eremicus*, *Lepus californicus deserticola*, and *Sylvilagus audubonii arizonae*.

Rock Land Habitat.—Boulders and piles of smaller rocks were characteristic of the sides of the desert washes near the bases of the mountains (fig. 13). Rocky outcrops were common in the foothills and in the mountains proper (figs. 10, 14, 25, and 31). The scattered vegetation that was present depended upon the

FIG. 13. Foothill wash at Rock Spring with catclaw, mesquite, rabbit brush, and sagebrush along borders. Photograph taken May 27, 1938.

position of the rock land in relation to the plant belts. Cacti, Spanish dagger, Spanish bayonet, and agave were characteristic plants at elevations below 5,500 feet, whereas small piñons and junipers were present in the rocks at higher elevations (fig. 10). The cliffs supported little or no plant life.

The characteristic vertebrates of the rock land habitat were *Crotaphytus collaris baileyi*, *Sauromalus obesus*, *Crotalus mitchellii pyrrhus*, *Buteo jamaicensis calurus*, *Falco mexicanus*, *Aëronautes saxatalis saxatalis*, *Tachycinata thalassina lepida*, *Salpinctes obsoletus obsoletus*, *Bassariscus astutus*, *Spilogale gracilis gracilis*, *Citellus variegatus grammurus*, *Perognathus formosus mohavenis* and *Peromyscus crinitus stephensi*.

Canyon Habitat.—The canyons in the piñon and white fir belts supported mesophytic brushy vegetation of which *Garrya flavescens* was a typical shrub. The trees in such areas often attained maximum size for the region. Rock surfaces often were extensive and prevented continuous tree or bush growth. *Sceloporus occidentalis biseriatus*, *Selasphorus platycercus platycercus*, *Aphelo-*

coma coerulescens nevadae, *Thryomanes bewickii eremophilus*, *Catherpes mexicanus conspersus*, *Hylocichla guttata guttata* [*winter*], *Chlorura chlorura*, *Pipilo maculatus montanus*, and *Urocyon cinereoargenteus scottii* were present in this habitat in their greatest numbers.

Spring Habitat.—The presence of springs, and the willows, elderberries, and cottonwoods associated with them, influenced many of the vertebrates of the area, although *Bufo punctatus* was the only species restricted to this habitat. *Lophortyx gambelii gambelii*, *Zenaidura macroura marginella*, *Carpodacus mexicanus frontalis*, *Spinus psaltria hesperophilus* and the species of bats were conspicuously dependent on the water from the springs. Springside vegetation was particularly attractive to *Bombycilla cedrorum* and *Passerina amoena*, as also to many migrant and vagrant birds.

Man-made Habitat.—Man has altered the natural conditions of the region in many ways, but the sections so altered form but a small part of the whole area. Pools of water have been formed by placing dams below springs, and water has been piped from the springs and wells to troughs and tanks. Special watering places have been constructed for the quail. These changes have expanded the area influenced by water and, in addition to the animals mentioned in connection with the spring habitat, constitute an important factor in the lives of *Sialia currucoides*, *Agelaius phoeniceus sonoriensis*, *Molothrus ater obscurus*, and *Anthus spinoletta pacificus*. A peach orchard situated near Pachalka Spring was a favored site for *Eumeces gilberti rubricaudatus*, *Passerina amoena*, and *Thomomys bottae providentialis*. Perches and observation posts built by man were often used by *Tyrannus verticalis* and *Sialia currucoides*. Buildings and bridges were used by *Sayornis saya saya*, *Passer domesticus*, and *Neotoma lepida lepida*. *Eremophila alpestris* was found principally in clearings that had been made in the yucca belt.

Common names of plants are used in most of the report. Those most often referred to, with their scientific names, are as follows: piñon pine (*Pinus cembroides* var. *monophylla*), white fir (*Abies concolor*), juniper (*Juniperus californica*), ephedra (*Ephedra* sp.), Joshua tree (*Yucca brevifolia*), Spanish dagger (*Yucca mohavensis*), Spanish bayonet (*Yucca baccata*), agave (*Agave utahensis*), purshia (*Purshia glandulosa*), cottonwood (*Populus* sp.), currant bush (*Ribes cereum*), mesquite (*Prosopis juliflora* var. *glandulosa*), catclaw (*Acacia greggii*), creosote bush (*Larrea tridentata*), cholla (*Opuntia bigelovii*), sagebrush (*Artemisia tridentata*), desert willow (*Chilopsis linearis*), elderberry (*Sambucus glauca*), rabbit brush (*Chrysothamnus nauseosus*), and burro weed (*Franseria dumosa*).

FAUNAL RELATIONSHIPS

The concept of biotic provinces, which currently receives much attention, we think has some serious inadequacies. All major distributional categories such as life-zones, plant belts, and biomes have their defects arising from the fact that each species constitutes a separate reaction system, responding in its own way to limiting factors and establishing its own distributional equilibrium. But biotic provinces are much less satisfactory than the other units, for they

are a mozaic of zonal and formational elements of unspecified proportion. Dice, a leading proponent of biotic provinces, states (1943:4) that "each province is characterized usually by a single climax association, but two or more climaxes may sometimes be represented within a single province. This often happens on mountains, where each life belt may have a different climax." It is readily apparent in reviewing his maps and descriptions that most of his provinces encompass a number of vegetational climaxes or biomes and it is not at all clear how prevalent one climax must be to "characterize" an area. Must it cover 25, 65, or 90 per cent of the area? Must it be scarce or absent in other provinces, and to what degree? We do not think these questions can be answered sensibly. The province is largely a subjective thing.

Other writers, emphasizing the complex of species present in an area, state that a biotic province embraces a "natural general grouping" of species, or "characteristic assemblage" of species; but the members are not necessarily confined to a single province in all instances (Goldman and Moore, 1945:347-348). But are not all groupings of species in nature "natural," and what defines a characteristic assemblage? A biotic area has significance, we now think, only as its fauna contains unique forms and as its limits are set by the approximate coincidence of range boundaries of the unique forms and of parts of the boundaries of other members of its fauna. In continental areas boundaries will be sharp largely in conformance with the distinctness of boundaries of plant formations. How many ranges must coincide to set a boundary, and how many unique forms must there be? We find an evenly graded set of values here and any hierarchy of biotic units becomes arbitrary. Various authors will continue to handle biotic units according to their own tastes. The units may be used for general descriptive purposes but we do not expect that a satisfying distributional system will emerge.

At this juncture it is well to point out that too much stress can easily be placed on purely geographic units as Dunn (1922:336) and recently Mayr (1946:5) have clearly warned. It is best to view species of animals as composing faunas—associations of species with similar, though not identical, climatic and biotic tolerances, with ranges partly in common, and often with similar areas of origin as species. Faunas are of course fluid; species are added, others dropped out in the course of time. Definitions of faunas may prove just as elusive as those of biotic provinces. Nonetheless faunas seem often to be more cohesive entities, less subject to the pattern of local geographic barriers than are faunal or biotic districts and more fundamentally constituted by reason of common biologic traits. Thus, for example, we may in the present study best speak descriptively of the Sonoran desert fauna and of the piñon-juniper and the sagebrush faunas of the Great Basin.

The Mohave Desert as a geographic area is unmistakably different from the Colorado Desert area in topography and in its biota, particularly its flora (see Parish, 1930). It is chiefly an elevated series of desert basins which was not in recent geologic history flooded by the ocean; it has numerous small mountain ranges of which the Providence-Clark Mountain group is the largest and highest south of the Inyo and Charleston areas. Parish (*op. cit.*) reports that only

about half of the xerophilous phanerogam plants of the Mohave Desert occur in the Colorado Desert. Nevertheless the scrub formations of the two deserts are fundamentally the same as far as vertebrate habitats are concerned. The piñon woodland on the other hand is that of the Great Basin. The Mohave Desert is a junction area where, at appropriate zonal levels, the desert scrub formation with its vertebrate fauna and the piñon woodland and sagebrush with their fauna coexist. The white fir belt and its fauna in the Mohave Desert proper south of the Inyo section and the Charleston Mountains are a minor element, probably a remnant of a once more widespread northern biota. Unique and "characteristic" of the Mohave Desert is the Joshua tree woodland. Yuccas elsewhere do not dominate the vegetation in such a decisive fashion and seldom are a major factor in vertebrate habitats.

It is not a function of this report to deal with the whole vertebrate fauna of the Mohave Desert or fully to describe that desert as a geographic or biotic unit. The Providence Mountains area is a sample section of the Mohave Desert affording zonal and associational diversity. We will attempt to show the relation of the vertebrate fauna of this limited section to the several faunas that adjoin the Mohave Desert. Detailed comparison with the fauna of northern Arizona, which adjoins the Mohave Desert in extreme eastern Nevada and southwestern Utah, is not undertaken, as this fauna is less perfectly known than the others.

The study area lies on the eastern side of the Mohave Desert near the Colorado River valley, but it does not abut directly on it. Grinnell's (1914) analysis of the birds and mammals of the lower Colorado River valley emphasizes that the valley is a part of the Colorado Desert even at the latitude of the Providence Mountains, that it is zonally Lower Sonoran throughout and that the local distributions of species in the valley are all explainable in terms of particular plant associations and the water barrier. Some small differences in the fauna of the valley in the Needles district as against that in the Yuma district have subsequently come to light, but these differences are not conspicuous.

The Death Valley region to the northwest lies beyond the limits of the Mohave Desert proper in the Inyo district. The desert levels of Death Valley (see Grinnell, 1923*a*, 1937) are related to the Mohave Desert, but the yucca belt is lacking. The piñon belt of that section (Miller, 1946) has much in common with that of the Providence Mountains.

Reptiles

Two of the 28 reptiles (7 per cent) of the Providence Mountains are peculiar to the Mohave Desert fauna (see table 2). Twenty-one forms (75 per cent) are members of the Colorado or Sonoran Desert fauna and 10 relate exclusively to that fauna among the major faunas here compared; 2 of the species of the area have racial counterparts in the Colorado Desert proper. Thirteen of the forms (46 per cent) are members of the Great Basin fauna, either of the sagebrush–salt desert or the piñon-juniper (see Hall, 1946) divisions; only one form relates particularly to that fauna and to that of northern Arizona; three species have

TABLE 2

Occurrence of Reptiles in the Providence Mountains and in Related Faunas

Name	Providence Mts. plant belt					Faunas						Notes
	Undetermined	Creosote	Yucca	Sagebrush	Piñon	Colorado Desert	Great Basin sagebrush	Great Basin piñon	San Diegan	San Joaquin	Death Valley low desert	
Coleonyx variegatus variegatus			x			x			sp[1]		x	[1]sp = another race of the species present
Dipsosaurus dorsalis dorsalis		x				x						
Crotophytus collaris baileyi			x			x	x				x	
Gambelia wislizenii wislizenii		x	x			x	x			sp	x	
Sauromalus obesus		x	x			x					x	
Callisaurus dracanoides gabbii		x	x			x	sp				x	
Uma scoparia		x										
Urosaurus graciosus		x				x						
Uta stansburiana stejnegeri		x	x	x	x	x	sp	sp	sp	sp	x	
Sceloporus magister		x	x			x	x			x	x	
Sceloporus occidentalis biseriatus					x		x	x	x	x		
Phrynosoma platyrhinos platyrhinos		x	x			x	x				x	
Xantusia vigilis			x			x				x	x	Marginally in San Diegan district
Cnemidophorus tesselatus tesselatus		x	x	x	x	x	x	x	sp	sp	x	
Eumeces gilberti rubricaudatus			x		x				x			Marginally in San Joaquin area
Lichanura roseofusca gracia	x					x			sp			
Coluber flagellum frenatum		x	x			x	x		x	x	x	
Coluber taeniatus taeniatus					x			x				
Salvadora hexalepis hexalepis		x	x			x	x		sp		x	
Pituophis catenifer deserticola			x			sp	x	x	sp		x	
Lampropeltis getulus boylii	x						x	x	x	x		
Rhinocheilus lecontei clarus	x					x	sp		sp	sp		
Sonora miniata linearis	x					x	x					
Hypsiglena ochrorhyncha	x					x	x		x	x	x	
Crotalus cerastes cerastes		x				sp[1]					x	[1]Same race occurs in Needles district
Crotalus scutulatus		x				x						
Crotalus mitchellii pyrrhus		x[1]				x				x	sp	[1]Southern part of area only, see p. 275
Gopherus agassizii		x	x	x	x	x						

racial counterparts in the Great Basin. Six (21 per cent) of the forms are members of the fauna of the San Diegan district of coastal California; only one relates exclusively to that fauna but 4 relate jointly to the San Diegan and Great Basin faunas; 7 species have racial counterparts in the San Diegan fauna. Six forms of the Providence Mountains also are members of the fauna of the southern and western San Joaquin Valley.

The foregoing summarization makes it clear that the Providence Mountains area and the Mohave Desert generally derive their reptiles chiefly from the Sonoran desert fauna; in fact the reptiles of the area represent in the main a mere northward extension of that fauna, with slight impoverishment of it and with minor endemic modification. This extension reaches into the lower zones of the Mohave Desert. Of the 21 Sonoran Desert members only 3 clearly are established in belts above the creosote and yucca associations of the study area. Nine of the Great Basin species in the Providence Mountains fauna represent the part of the Sonoran Desert fauna that extends on northward past the Mohave Desert. The remaining reptiles from this fauna are chiefly those of higher zonal levels or they are those that occur both in the Great Basin and in coastal California. They are found for the most part in the upper belts of the Providence Mountains.

The reptiles of the desert or Lower Sonoran levels of Death Valley represent an extension northward of the fauna of the lower belts of the Mohave Desert but apparently with the loss of 5 species that occur in the Providence area.

Birds

Only the birds that are summer resident or permanently resident in the Providence Mountain area, 68 in all, are properly used in faunal comparisons. The relation of the small group of birds that occurs exclusively in the fir forest to other faunas, principally montane, is indicated by annotations in table 3. The sagebrush and piñon avifaunas of the Great Basin have much in common; many species of birds normally use a combination of the vegetative facilities of sagebrush and piñon associations (see Miller, 1946).

Only one race of bird may be considered endemic in the Providence area, and this form, the bush-tit (*P. m. providentialis*), extends north into the mountains of the southern Great Basin through the Inyo region. It might be regarded in fact as a differentiate of the Inyo region except that it shows its characteristics most strongly in the Providence Mountains area. Thirty-five (53 per cent) of the birds of the Providence area are members of the Colorado or Sonoran desert fauna and 8 relate exclusively to that fauna among those here tabulated; 3 species have racial counterparts in that fauna. Forty-four forms (65 per cent) are members of the Great Basin fauna (all Upper Sonoran divisions), although several occur only in a restricted southern section of the Great Basin; 15 relate only to the Great Basin among the faunas tabulated but 9 of these are members also of other faunas, chiefly the montane forest fauna or oak woodland or chaparral faunas occurring to the north and east; 4 species in the Providence Mountains have racial counterparts in the Great Basin. Thirty-three forms (49 per cent) are members of the fauna of the San

TABLE 3

OCCURRENCE OF BIRDS IN THE PROVIDENCE MOUNTAINS AND IN RELATED FAUNAS

Name	Providence Mts. plant belt						Faunas						Notes
	Undetermined	Creosote	Yucca	Sagebrush	Piñon	Fir	Colorado Desert	Great Basin sagebrush	Great Basin piñon	San Diegan	San Joaquin	Death Valley low desert	
Cathartes aura teter		x	x	x	x		x	x	x	x	x	x	
Accipiter cooperii					x		1		x	x			[1]Riparian only
Buteo jamaicensis calurus		x	x	x	x		x	x	x	x	x	x	
Buteo swainsoni			x				x	x	x	x	x	x	
Aquila chrysaëtos canadensis		x	x	x	x		x	x	x	x	x	x	
Falco mexicanus		x	x	x	x		x	x	x	x	x	x	
Falco sparverius sparverius			x		x		x	x	x	x	x	x	
Lophortyx gambelii gambelii		x	x				x					x	
Zenaidura macroura marginella		x	x				x	x	x	x	x	x	
Geococcyx californianus		x	x				x			x	x	x	
Otus flammeolus						x							Montane forest fauna generally
Otus asio cineraceus					x		sp[1]	sp	x	sp	sp		Also oak belt fauna of Arizona; [1]sp = another race of the species present
Otus asio gilmani			x		x		x	sp	sp	sp	sp		
Bubo virginianus pallescens		x	x	x	x		x	sp	sp	sp	sp	x	
Speotyto cunicularia hypugaea		x					x	x	x	x	x	x	
Phalaenoptilus nuttallii nuttallii			x		x		sp	x	x	sp	sp	x[1]	[1]Probably not breeding below sagebrush and piñon belts
Chordeiles acutipennis texensis		x	x				x			x	x	x	
Aëronautes saxatalis saxatalis			x		x	x	x	x	x	x	x	x	
Calypte costae		x	x	x	x		x	x		x	x	x	
Selasphorus platycercus platycercus					x	x			x				Montane fauna to eastward and northward

TABLE 3—Continued

OCCURRENCE OF BIRDS IN THE PROVIDENCE MOUNTAINS AND IN RELATED FAUNAS

Name	Providence Mts. plant belt						Faunas						Notes
	Undetermined	Creosote	Yucca	Sagebrush	Piñon	Fir	Colorado Desert	Great Basin sagebrush	Great Basin piñon	San Diegan	San Joaquin	Death Valley low desert	
Colaptes chrysoides mearnsi			x				x						
Dendrocopos villosus leucothorectis						x			x	sp			Montane fauna to eastward and northward
Dendrocopos scalaris cactophilus			x				x						
Tyrannus verticalis			x	x			x	x	x	x	x	x	
Tyrannus vociferans vociferans					x					x	x		Also oak belt fauna of Arizona
Myiarchus cinerascens cinerascens		x	x	x	x		x	x	x	x	x	x	
Sayornis saya saya		x	x	x			x[1]	x[1]	x	x	x	x[1]	[1]Desert populations may prove racially distinct
Eremophila alpestris leucansiptila		x	x				x	sp		sp	sp	sp	
Tachycineta thalassina lepida			x		x	x			x	x			Also montane forest fauna
Aphelocoma coerulescens nevadae			x	x	x			x	x	sp	sp		
Corvus corax sinuatus		x	x				x	x	x	x	x	x	
Gymnorhinus cyanocephalus			x	x	x				x				
Parus gambeli inyoensis						x							Montane forest fauna of Great Basin
Parus inornatus ridgwayi					x				x	sp	sp		
Auriparus flaviceps acaciarum		x					x					x	
Psaltriparus minimus providentialis				x	x			x[1]	x[1]	sp	sp		[1]Restrictedly in southern Great Basin
Thryomanes bewickii eremophilus			x	x	x			x	x	sp	sp		
Campylorhynchus brunneicapillus couesi			x				x			x			
Catherpes mexicanus conspersus			x		x			x	x	x	x		
Salpinctes obsoletus obsoletus		x	x	x	x		x	x	x	x	x	x	
Mimus polyglottos leucopterus		x	x				x	x		x	x	x	
Toxostoma bendirei			x				x						

Toxostoma lecontei lecontei		x					x				x	x	
Toxostoma dorsale dorsale			x	x			sp[1]						[1]Same race occurs in Colorado River valley in Needles area and east into Arizona
Hylocichla guttata polionota						x							Montane forest fauna of Great Basin
Sialia mexicana bairdi						x			sp	sp	sp		Montane forest fauna of southern Great Basin and southern Rocky Mts.
Polioptila caerulea amoenissima			x	x	x				x	x	x		
Phainopepla nitens lepida		x	x	x			x			x	x	x	
Lanius ludovicianus nevadensis		x	x				sp	x	x	sp	x	x	
Vireo vicinior				x	x			x[1]	x[1]	x			[1]Restrictedly in southern Great Basin
Vermivora virginiae						x			x[1]				[1]Chiefly lower montane fauna of Great Basin and Rocky Mts.
Dendroica nigrescens					x	x			x	x			
Passer domesticus domesticus	x						x	x		x	x	x	
Icterus cucullatus californicus					x		x[1]			x	x	x	[1]In part another race
Icterus parisorum		x	x	x	x		[1]		x	[1]			[1]Marginally or locally
Molothrus ater obscurus			x		x		x	sp	sp	x	x	x	
Pheucticus melanocephalus melanocephalus					x			x	x	sp	sp		Also montane fauna to east
Passerina amoena	x							x	x	x	x		
Carpodacus mexicanus frontalis		x	x	x	x		x	x	x	x	x	x	
Spinus pinus pinus						x							Montane forest fauna generally
Spinus psaltria hesperophilus			x		x		x	x	x	x	x	x	
Loxia curvirostra grinnelli					x								Chiefly montane forest fauna of Sierra Nevada
Chlorura chlorura					x			x	x				Also montane chaparral fauna
Pipilo maculatus montanus			x		x			x[1]	x[1]	sp	sp		[1]In part another race; also Rocky Mt. fauna
Amphispiza bilineata deserticola		x	x	x			x	x			x	x	
Junco caniceps caniceps						x							Montane forest fauna of Great Basin and Rocky Mts.
Spizella breweri breweri			x	x				x		[1]	x		[1]Locally
Spizella atrogularis evura				x	x			x[1]	x[1]	sp	sp		[1]Restrictedly in southern Great Basin; also Arizona chaparral fauna

Diegan district but none relates exclusively to that fauna; 14 species have racial counterparts in the San Diegan fauna. Thirty-two forms (47 per cent) are members of the fauna of the southern and western San Joaquin Valley, but none relates exclusively to that fauna or to the San Diegan and San Joaquin faunas in combination; *Tyrannus vociferans*, which appears to do so, actually has a spotted, widespread occurrence in Arizona woodlands and in the Rocky Mountains. Twelve species have racial counterparts in the San Joaquin fauna.

There is a large proportion (28 per cent) of the avian species that are widespread and occur in all major faunas adjacent to the Mohave Desert. Apart from these there is a mixture of about equal proportions of an element from the Sonoran Desert, which for the most part occurs in the creosote and yucca belts, and one from the Great Basin and eastern montane woodlands, which in the Providence Mountains occurs chiefly in the piñon and sagebrush belts. This restriction as to belt of occurrence is, as might be expected, more nearly perfect among those species which are exclusively related to southern and northern faunas, respectively. Special affinities to the faunas of coastal California are not strong, for a majority of the forms occurring both on the coast and in the Mohave Desert are those of widespread western distribution and there is a substantial number (12-14) of species that are racially distinct when they occur in both regions.

The affinities of 6 of the group of 8 species found in the white fir timber on Clark Mountain are with the montane forest faunas of the adjoining Great Basin; four of these are southern Rocky Mountain types also. Two species are of widespread montane occurrence.

The low desert avifauna of Death Valley lacks five species of birds of the Colorado Desert element which are present in the Providence area. One species (*Eremophila alpestris*) is represented in Death Valley by populations of slightly different character (see p. 301). The situation in birds parallels that in reptiles in Death Valley with respect to impoverishment of the Sonoran element.

In sharp contrast with reptiles, the birds of the Providence area show a northern element somewhat larger than the southern element. This of course reflects the generally greater tolerance of birds for the higher, cooler, zonal levels.

Mammals

The mammalian fauna of the Providence Mountains consists of 38 forms which are of normal occurrence in the area; half of these are rodents. The rodents particularly are broken up into races occupying restricted ranges. As a consequence the mammalian fauna shows more endemism than the reptilian and avian faunas, and the forms that range in from surrounding areas, as for example, the Great Basin, seldom are representative of the entire Great Basin, but only of its adjoining southern portion (see Hall, 1946). The bats and carnivores more nearly parallel the other classes of terrestrial vertebrates in racial subdivision.

Six forms (16 per cent) of mammals appear in table 4 to be peculiar to the Mohave Desert or to that part of it in which the Providence Mountains lie. However, two of these (*Spilogale* and *Erethizon*) range in from northern Ari-

TABLE 4

OCCURRENCE OF MAMMALS IN THE PROVIDENCE MOUNTAINS AND IN RELATED FAUNAS

Name	Providence Mts. plant belt						Faunas						Notes
	Undetermined	Creosote	Yucca	Sagebrush	Piñon	Fir	Colorado Desert	Great Basin sagebrush and salt desert	Great Basin piñon	San Diegan	San Joaquin	Death Valley low desert	
Myotis thysanodes thysanodes	x						x	x		x	x		
Myotis volans interior	x							x	x	x	x		
Myotis californicus stephensi	x						x	x		sp	sp	x	sp = another race of the species present
Myotis subulatus melanorhinus	x							x	x	x	x		
Pipistrellus hesperus hesperus		x	x	x	x		x	x		sp	sp	x	
Eptesicus fuscus pallidus	x						x	x	x	sp	sp		
Lasiurus cinereus cinereus	x							[1]	[1]	[1]	[1]	[1]	[1]Probably only transient; occurs in montane faunas
Corynorhinus rafinesquii pallescens	x						x	x	x	x	sp		
Antrozous pallidus pallidus	x						x	x		sp	sp	x	
Bassariscus astutus [nevadensis][1]			x		x		sp?	?		sp	sp		[1]Assumed racial identity
Spilogale gracilis gracilis			x	x	x		sp	sp[1]	sp[1]	sp	sp		[1]Extends into southern Great Basin and along upper Colorado River in Arizona
Taxidea taxus berlandieri		x	x	x	x		x	sp[1]	sp[1]	sp	sp	x	[1]This race extends into southern Great Basin and eastward
Vulpes macrotis arsipus		x	x				x	sp		sp	sp	x	
Urocyon cinereoargenteus scottii			x		x		x	x	x	sp	sp		
Canis latrans estor		x	x	x	x		x	sp	sp	sp	sp	x	

TABLE 4—Continued

Name	Providence Mts. plant belt: Undetermined	Creosote	Yucca	Sagebrush	Piñon	Fir	Faunas: Colorado Desert	Great Basin sagebrush and salt desert	Great Basin piñon	San Diegan	San Joaquin	Death Valley low desert	Notes
Lynx rufus baileyi			x		x		x	x	x	sp	sp	x	
Citellus tereticaudus tereticaudus		x					x					sp	
Citellus variegatus grammurus			x		x			x	x				Also in Rocky Mt. fauna
Ammospermophilus leucurus leucurus		x	x	x	x		x	x	x			x	
Eutamias panamintinus panamintinus					x	x							Restricted to piñon belt of Inyo district and Charleston Mts.
Thomomys bottae providentialis		x	x				sp	sp	sp	sp	sp	sp	Local endemic
Perognathus longimembris longimembris		x	x	x			sp	sp		sp	x	sp	
Perognathus formosus mohavensis			x		x		sp	x				x	
Dipodomys microps occidentalis			x					x				sp	
Dipodomys panamintinus caudatus			x	x				sp	sp				Local endemic
Dipodomys merriami merriami		x	x				sp[1]	x				x	[1]Same race in Needles area
Dipodomys deserti deserti		x					x	x				x	
Onychomys torridus pulcher			x	x			x	sp		sp	sp	sp	
Reithrodontomys megalotis megalotis				x			x	x	x	sp	sp	x	
Peromyscus crinitus stephensi		x	x	x	x		x	x	x			x	
Peromyscus eremicus eremicus		x	x	x			x			sp		x	
Peromyscus maniculatus sonoriensis			x	x			x	x	x	sp	x	x	
Peromyscus truei truei			x	x	x			x	x	sp	x		
Neotoma lepida lepida		x	x	x	x		sp	x	x	sp	sp	x	
Erethizon epixanthum [couesi][1]					x				sp				[1]Assumed racial identity; ranges into northern Arizona
Lepus californicus deserticola		x	x	x	x		x	x	x	sp	sp	x	
Sylvilagus audubonii arizonae		x	x	x			x	x		sp	sp	x	
Ovis canadensis nelsoni				x		x	x	x	x		x[1]	x	[1]Formerly

zona along the upper Colorado River and are not, in fact, limited to the Mohave Desert or the eastern section of it. The race of *Spilogale* ranges through the Inyo Mountains, moreover, and the race of *Erethizon* is uncertain, for its identity is inferred only from evidence of occurrence in adjoining areas to the north. The *Bassariscus* again is of assumed racial identification and its range in the Inyo district and in southern Nevada and along the Colorado River is scantily known. The races of *Thomomys* and *Dipodomys* are true local endemics; the *Eutamias*, like the bush-tit, is an endemic of the piñon belt of the Inyo region, the Providence Mountains, and the southwestern border of Nevada. The percentage of endemism is therefore lower than the tabulation would indicate and may be estimated at about 10 per cent.

Twenty-two (58 per cent) of the forms in the Providence Mountains are also members of the Colorado or Sonoran desert fauna, and 6 relate only to that fauna among the major faunas here compared; 6 species have racial counterparts in that fauna. Twenty-four forms (63 per cent) are members of the Great Basin fauna, at least of southern divisions of it or of the salt-desert part of the Upper Sonoran fauna (see Hall, 1946); 5 relate only to that fauna among those tabulated; 9 species have racial counterparts in the adjacent Great Basin. Only 4 forms (11 per cent) are members of the fauna of the San Diegan district and none relates exclusively to it; 21 species have racial counterparts in that fauna. Seven forms (18 per cent) are members of the fauna of the southern and western San Joaquin Valley; 18 species have racial counterparts in that fauna. Only one form, *Perognathus l. longimembris*, relates exclusively to that fauna, but it is not widespread in the San Joaquin Valley and may better be characterized as extending marginally into it from its main center in the Mohave Desert; it is essentially an endemic of the Mohave area.

As with birds, the mammalian fauna of the Providence Mountains is about equally divided between the Great Basin and Colorado Desert elements. There are fewer forms of widespread occurrence and there are more endemics. The affinities with the faunas of the San Diegan district and the San Joaquin Valley district are much weaker than the affinities of the corresponding bird faunas because racial differentiation between populations of mammals of coastal and desert areas is greater.

The mammalian fauna of the desert levels of Death Valley apparently lacks 4 species of the Colorado Desert element found in the Providence area, but 3 of these are bats that may yet prove to occur in Death Valley at low levels if not on the valley floor. Five species, two of which are of the Colorado Desert element, have races in Death Valley different from those in the Providence area.

Summary.—Table 5 shows in percentages the resemblance of the Providence Mountains fauna to other faunas, as also the proportion of endemics. The proportion of racial differentiation between faunas, in antithesis, reflects dissimilarity, at least on the racial level.

The general conclusion drawn from analysis of the terrestrial vertebrate fauna is that the Mohave Desert is primarily an area of junction of Great Basin and Sonoran Desert faunas with few endemic elements of its own. The

Providence fauna is much more strongly related to either one of these two than to those of coastal California. The Death Valley area at its lower levels is fairly well set off faunally from the Providence section of the Mohave Desert by reason of reduction in numbers of low-zone forms and a slight amount of racial differentiation. The faunas of the upper belts or zones of these two areas are closely related, however, as is also that of the Charleston Mountains in Nevada. The montane element has stronger affinities with the fauna of the Rocky Mountains than with that of the Sierra Nevada.

TABLE 5

SUMMARY OF RELATIONSHIPS OF FAUNAS

	Total no. in Providence fauna	Percentage of forms in common				Percentage of endemics
		Colorado Desert	Great Basin	San Diegan	San Joaquin	
Reptiles	28	75	46	21	21	7
Birds	68	53	65	49	47	1
Mammals	38	58	63	11	18	10
Total fauna	134	59	60	32	34	5
	Percentage relating exclusively to each fauna					
Reptiles	28	36	4	4	0	
Birds	68	12	22	0	0	
Mammals	38	16	13	0	3	
Total fauna	134	18	16	1	1	
	Percentage of species with racial counterparts					
Reptiles	28	7	11	25	18	
Birds	68	4	6	21	18	
Mammals	38	16	24	55	47	
Total fauna	134	8	12	31	26	

LOCALITIES

North and Northwest Sides of Clark Mountain.—Camp was made in the lower part of the piñon belt on the north side of Clark Mountain, at an altitude of 5,400 feet. The mesa north of the mountain supports a good stand of Joshua trees up to an altitude of 4,500 feet. Above this is a mixed belt of Joshua trees, Spanish dagger, Spanish bayonet, and agave, which merges with the piñon belt at an altitude of 5,000 feet. The gradient is steep above this elevation and in most places above 6,000 feet is precipitous. Numerous narrow, V-shaped canyons lead from the crest of the mountain. In the shadows of the crest there are several pockets which receive but little direct sunshine at any time of the year, and in these there are patches of white fir, which are the only representatives of a Transition Zone flora in the area (Miller, 1940).

There is no permanent water on the north side of Clark Mountain, although there are several springs about four miles to the east. Snow remains in the upper parts of some of the canyons until late spring or early summer. The water from the melting snow immediately goes into the ground. Small depressions in the canyons hold rain water for short periods, but the rains are too infrequent directly to influence the presence of animals.

Habitats represented at this locality are: yucca, desert wash, rock land, piñon, canyon, and white fir.

Pachalka Spring.—This is a permanent spring on the west side of Clark Mountain at an altitude of 4,800 feet. It has been used for many years as a base from which prospectors have worked on this side of the mountain. At one time the ore was removed to the now abandoned smelter at Valley Wells (of the U. S. Geological Survey topographic sheet; not the service station now called Valley Wells). Several small houses are present and the remains of others are scattered about the area. A pipe leads from the spring into a small pool, from which the water flows into a peach orchard and is absorbed by the soil. Cottonwood and willow trees and elderberry bushes occur near the spring. Mesquite and catclaw are more abundant in the desert wash below the orchard than at other places in the vicinity.

Camp was made at the spring. It was in the upper part of the yucca belt, about 400 feet below the piñons. Several washes radiate from the base of the mountain near the spring. The mesa slopes gradually toward the valley west of the mountain. There is an extensive overlap of the yucca and creosote bush belts on the mesa, the yuccas becoming the more prominent of the two above an altitude of about 3,500 feet.

The habitats studied in this area are: yucca, rock land, desert wash, spring, and man made.

Valley Eight Miles West of Clark Mountain.—The valley west of Clark Mountain and north of the Valley Wells service station is nearly flat and supports a normal stand of creosote bush with some yuccas interspersed (fig. 3). A wash runs lengthwise through the valley, along which there are a few small areas of wind-blown sand.

Habitats here are: sand dune, creosote bush, and desert wash.

South and Southeast Sides of Clark Mountain.—The southeast side of Clark Mountain resembles the north side in its topography, but is not as precipitous. White firs are absent, and the corresponding belts of other plants are at higher elevations because of the slope exposure. Our camp was situated in the lower part of the piñon belt at an altitude of 6,300 feet. It was in a broad canyon which opens onto the mesa northeast of Mohawk Hill. The mesa and the foothills are in the yucca belt. Scattered junipers extend down into the yucca belt, but the piñon belt proper begins at an elevation of about 5,300 feet and continues to the crest of the mountain. Intermittent rains and the winter's snow provide the only water on this side of the mountain.

Habitats present here are: yucca, desert wash, piñon, canyon, and rock land.

Mountain Pass.—Mountain Pass is at the summit of the divide between the Mescal Range and Clark Mountain, at an altitude of 4,750 feet. It is a small

settlement on U. S. Highway 466. The pass is in the yucca belt. Members of our party stopped here several times, but no camps were made.

Wheaton Spring.—This settlement is on U. S. Highway 466 at the north end of Mineral Hill, in the Ivanpah Mountains, at an altitude of 4,200 feet. It is in the yucca belt. Klauber (1932) collected here.

Mescal Cave.—This cave is situated near the top of the southwest wall of a deep and narrow canyon in the northwestern part of the Mescal Range, at an altitude of 5,500 feet. The lower part of the canyon is in the yucca belt and has typical desert wash vegetation in the bottom. The piñon and yucca belts meet at an elevation of about 5,000 feet. The cave was originally an eroded place in the side of the cliff, but it has been enlarged by mining operations. A party from the Department of Paleontology of the University of California has collected material from this cave. Many smaller caves are present in the walls of the canyon. Water seeps through the ceilings of some of the caves. The nearest permanent water is at Mescal Spring, two miles east of Mescal Cave.

Yucca, desert wash, canyon, rock land, and piñon habitats are present in this area.

Mescal Spring.—This spring is situated a few hundred yards south of U. S. Highway 466 in the valley between the Ivanpah Mountains and the Mescal Range, at an altitude of 5,000 feet. It issues from an old mine tunnel that has been dammed and it supplies water for many of the residents and their livestock in the surrounding area. It is in a desert wash in the yucca belt, which here meets the piñon belt at an altitude of about 5,300 feet.

Yucca, desert wash, rock land, piñon, spring, and man-made habitats are present in the vicinity of the spring.

Ivanpah Valley.—This large and extremely arid valley (fig. 6) is surrounded by mountains except at its southwestern end, where it merges with the Cima plateau. Parts of its floor below the 2,600-foot level are occupied by playa lakes, which have no vegetation. A narrow belt of *Atriplex* surrounds the barren areas. The creosote bush belt extends up to about 3,300 feet, where it meets the yucca belt that covers the mesa and the foothills of the mountains. The plant belts are more sharply delimited on the gradual slopes of Ivanpah Valley than in any other part of the area. There are scattered stretches of wind-blown sand in the creosote bush belt. Desert wash vegetation was not present in the parts of the valley that we visited. A camp was made near the pumping station, three miles north of Ivanpah. This camp was in the creosote belt. Collections were made at Murphy Well, in the creosote bush belt, and at Ivanpah at the junction of the creosote bush and yucca belts.

Nipton.—A town on the railway on the east side of Ivanpah Valley (see above).

Barnwell and Purdy.—Barnwell is situated at the south end of the pass in the New York Mountains at an altitude of 4,807 feet (fig. 4). It is in the upper part of the yucca belt, where there is an abundant mixture of junipers but no piñons. The latter are present a few hundred feet higher on the slopes of the mountains. Purdy is four miles south of Barnwell on the Barnwell-Goffs road.

It is in the yucca belt at an altitude of 4,500 feet. Desert washes are numerous in this section.

Lanfair Valley.—The plateau lying southeast of the New York Mountains; Purdy lies at the northwest edge of it.

Cima and vicinity.—Cima is a small settlement in the center of the plateau which lies between the Ivanpah Mountains and the Providence-New York Range at an altitude of 4,200 feet. The plateau supports the best stand of Joshua trees in the Providence Mountains area (fig. 7). These trees extend on the north and south to the bases of the mountains and also into Cedar Canyon. On the east they meet the creosote bush belt on the margin of Ivan-

FIG. 14. Cliff in Cedar Canyon with sagebrush and piñon-juniper habitats below it. The cliffs were frequented by red-tailed hawks and prairie falcons. Photograph taken May 21, 1938.

pah Valley and similarly extend westward toward Kelso. The plateau is grazed extensively. Many dry farms have been made by clearing the Joshua trees. Most of these farms have been abandoned, but it will be many years before the Joshua trees again cover the cleared areas; however, Spanish dagger and Spanish bayonet have returned rapidly.

The habitats present on the plateau are yucca or man made. In the foothills there are, in addition to these two, the desert wash and rock land habitats.

Camps were made as follows: three miles north of Cima at an elevation of 4,500 feet; two miles north-northeast of Cima, at 4,150 feet; two miles north of Cima, at 4,400 feet.

Five Miles North of Kelso Peak.—Camp was made here at an altitude of 4,000 feet. The surrounding area is hilly. The yucca and creosote bush belts are indistinct here.

Cedar Canyon.—The road from Cima to Essex passes through Cedar Can-

yon in the Mid Hills section of the Providence–New York Range (fig. 15). The altitude at the east end of the canyon is 5,100 feet and at the west end is 4,600 feet. The canyon thus slopes gradually from the east toward the west throughout its length of about two miles. It is broadly U-shaped at both ends and narrowly V-shaped in the middle. The rims of the canyon are over 5,500 feet in altitude, and the sides are cut by many side canyons. The floor is sandy in places and rocky in others, and it supports a typical desert wash flora except for the presence of rabbit brush. The yucca belt comes into the west end of the canyon from the Cima plateau and is present on the walls of the canyon. Above

FIG. 15. View southwest down Cedar Canyon. The piñon belt occupies the upper slopes with sagebrush and desert wash in the canyon bottom. Photograph taken May 24, 1938.

elevations of 4,800 feet, the yuccas are mixed with junipers. The piñon belt begins at about 5,000 feet, which is its general level over the New York Mountains to the northeast and the Providence Mountains to the southwest. The basin situated south and east of Cedar Canyon is filled with sagebrush and juniper, which association is not present elsewhere in the area.

Cedar Canyon is in the midst of a highly diversified area and presents the following habitats: yucca, desert wash, sagebrush, piñon, canyon, rock land, and spring. Because of this diversification and also because of the differences in vegetation on the northwest and southeast sides of the mountain range, more time was spent here than at any other locality (figs. 11, 14, 16, and 31).

Two camps were made on the north side of the canyon at altitudes of 5,300 and 5,000 feet.

Government Holes.—This locality is on the road leading from Cedar Canyon to Lanfair, about four miles east of the canyon. It has long been in use as a

cattle headquarters and, being on the old military route across the Mohave Desert, has doubtless been a camping place for over ninety years. At present there is a small house, a rock-walled room dug into the hillside, a windmill, and a cattle corral there. Government Holes is on the south side of a broad valley, at the north end of a piñon-covered spur of Table Mountain. The valley is covered with sagebrush, through which *Purshia* and juniper are interspersed (figs. 5 and 9). Habitats here are sagebrush, rock land, and man made.

Rock Spring.—The Cima-Lanfair road enters a large wash about two miles east of Government Holes and follows the wash in a southeasterly direction

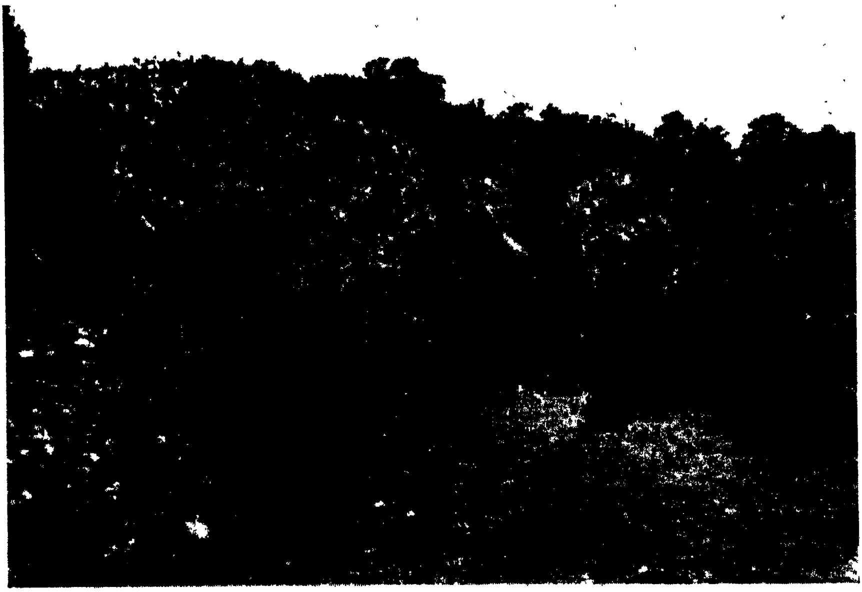


FIG. 16. Mixed vegetation in a side gulch in Cedar Canyon. Joshua trees and chollas here merge with piñons and junipers. On rocky exposures among the trees Panamint chipmunks, rock wrens, and spiny lizards occurred; on flatter ground, whip-tailed lizards and antelope ground squirrels. Photograph taken May 31, 1938.

for a short distance. Rock Spring is situated off the road in a small canyon that opens into the wash, at an elevation of 4,800 feet (fig. 13). The canyon has a sandy floor. There is a growth of mesquite, catclaw, and squaw bush along its margins. The large wash, like the surrounding uplands, is covered with sagebrush and rabbit brush, which continue down the wash to an elevation of 4,300 feet, the lowest level for the sagebrush in this area. The spring at one time produced ten gallons of water a minute, but in the past few years the volume has greatly decreased.

The habitats represented here are: desert wash, spring, rock land, and sagebrush.

Two Miles East-southeast of Rock Spring.—Camp was made in a clearing in the Joshua trees at an altitude of 4,700 feet. A *Purshia*-covered flat was nearby. This locality is near the western margin of the yucca belt on the south side of the New York Mountains. The closest permanent water is at Rock Spring.

Five Miles Northeast of Granite Well.—Camp was situated near the west base of Table Mountain and east of Black Canyon at an altitude of 5,400 feet. It was one-quarter mile south of the Lone Cove ranch headquaters. The hills and mountains in this vicinity are granitic, and granitic sand was abundant in the washes. Permanent water is present at the ranch headquarters, and three springs are present within three miles of camp. In fact, the basin north of Table Mountain probably has a greater annual supply of water than does any other part of this section of the Mohave Desert. The floor of the basin supports a heavy covering of sagebrush, through which juniper and *Purshia* are scattered. The isolated hills and the mountains are in the piñon belt. *Garrya* is present in the canyons in the mountains, and canyon live oak is sparsely represented.

Sagebrush, piñon, rock land, canyon, spring, and man-made habitats are present near this locality.

Six Miles South of Granite Well.—A large plateau extends eastward from the north end of the Providence Mountains for about six miles. Camp was situated in a semicircle of low hills at the base of a cliff on the southwest margin of the plateau, at an elevation of 3,600 feet. The rim of the cliff is basaltic and the rocks in this vicinity are, in general, of igneous origin. The rocks are often eroded into potholes and small caves. A small spring is present a short distance west of camp, which provides the only permanent water on this edge of the plateau.

This locality is in the yucca belt, which here has a vertical range between altitudes of 3,500 and 5,000 feet. A few junipers are present on the plateau. Creosote bush is the most abundant plant below the 3,300-foot contour.

Habitats represented in this area are: desert wash, rock land, creosote bush, yucca, and spring.

Bonanza King Mine.—This mine is situated on the east side of the Providence Mountains near the junction of the mountains proper and the plateau that extends eastward from its north end. The mine is at an altitude of 4,350 feet. Van Denburgh (1922) has reported on specimens collected at the mine.

Two and One-half Miles Southwest of Kelso.—Camp was established on the northwest margin of the sand dunes about one-quarter of a mile southwest of the Union Pacific Railway tracks, at an altitude of 2,100 feet. The area is flat except for shallow desert washes and the sand dunes. The nearest water is at Kelso. The sand dunes are in the creosote bush belt.

Flynn.—Station on the railway about 4 miles southwest of Kelso.

Mitchell's.—Mitchell's is situated on the east side of the highest part of the Providence Mountains, a few miles north of the pass which divides these mountains. Several abandoned mine tunnels are here. The mountains west of the settlement are precipitous and extremely rugged. Camp was near the boundary between the yucca and the piñon belts at an elevation of 4,500 feet. Piñons were present in suitable soil above this level, but much of the area of the mountains in this vicinity consists of bare cliffs. A spring above camp was surrounded by willows (*Salix*). The slopes below Mitchell's are steep and are in

the yucca belt. There are no Joshua trees in the yucca belt on this side of the mountains.

Habitats represented in this vicinity are: yucca, piñon, desert wash, canyon, spring, rock land, and man made.

Colton Well.—This is a well that has been dug in a desert wash situated in an area of mixed creosote bush and yucca. A windmill pumps the water to a storage tank and to an open, cement, watering trough. A special quail watering place has been built near the well. The surrounding area is characterized by numerous rocky hills and outcrops. The well may be reached by turning off the Essex–Bonanza King road about 100 yards at a point about one mile west of the easternmost spur of the Providence Mountains.

Northwest of Essex.—Essex is a small town on U. S. Highway 66, situated a little south of the southeastern corner of the area under consideration, at an altitude of 1,750. There is a gradually upward sloping plain between Essex and the Providence Mountains and Hackberry Mountain. Clipper Mountain and a few ridges rise above the level of the plain, but not to altitudes that permit a growth of piñons. The plain is in the creosote bush belt.

Pass Between the Granite and Providence Mountains.—This pass is in the southwestern corner of the Providence Mountains area, at an altitude of 4,000 feet. It is in the upper part of the yucca belt, but the characteristic plants of the creosote bush belt are more numerous than usual at this elevation. Junipers are present on the ridges bordering the pass, and the piñon belt begins a few hundred feet above the level of the pass. Snake Spring and Cottonwood Spring are nearby. Habitats studied here are: yucca, piñon, rock land, desert wash, and spring.

Hidden Hill Mine.—This mine is in the extreme southern end of the Providence Mountains. It is in the yucca belt.

AMPHIBIANS

Family Bufonidae

Bufo punctatus Baird and Girard

Spotted Toad

Pachalka Spring, May 31–June 1*[1]; Cedar Canyon, May 24–June 1*; Rock Spring, May 27, May 30*; Mitchell's, June 9-10*; Snake Spring, June 23-25*. Total specimens, 69.

Spotted toads were found in May and June in and about springs and small, temporary pools in rocky canyon bottoms. We found none in midwinter. All our records of occurrence are from elevations between 4,000 and 5,000 feet. This apparent altitudinal restriction results from the fact that the springs and residual pools used as breeding sites by the toads are most abundant along the bases of the mountains, where the rocky canyons are deepest and narrowest.

At Cedar Canyon the toads frequented small temporary pools in the beds of narrow, rock-walled canyons entering the main canyon from the north. There they were first detected on May 24, 1938, when their clear and prolonged trilling call was heard at 6:50 p.m. (early dusk). After dark, five adult toads were

[1] Asterisks indicate specimens taken.

collected with the aid of a flashlight in this vicinity. The mottled color pattern of the toads harmonized closely with the grayish granite on which they were found (fig. 17). On the following day a pair of clasping adults, some very small tadpoles, and many eggs were seen in a pool in a nearby canyon. Another pool contained tadpoles about an inch long. There were 27 toads in the open water of Pachalka Spring and many others on the adjacent boggy ground on the evening of May 31, 1939.

Most of the natural springs in the area have been enlarged and made more or less permanent by miners and stockmen so as to provide a more dependable

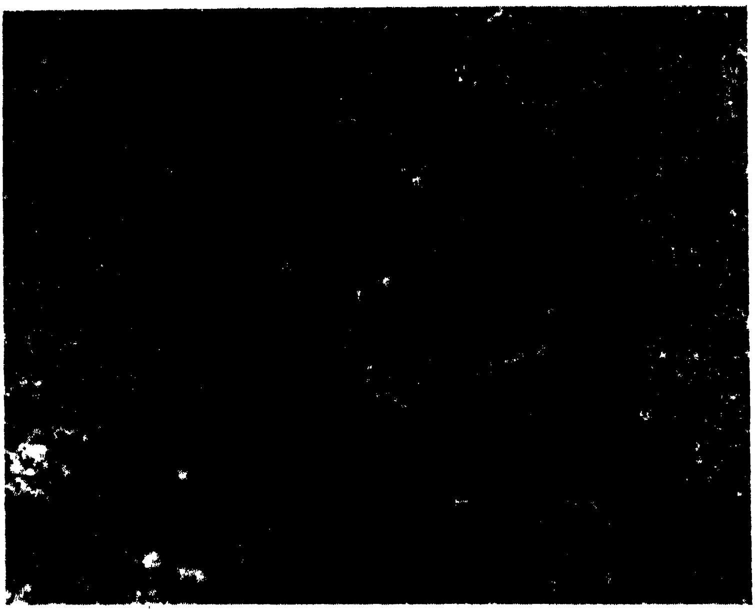


Fig. 17. Spotted toad on granite rock, showing protective coloration. Photograph taken May 25, 1938, in Cedar Canyon.

supply of water for men and livestock. An example of how this activity has benefited the spotted toad population was seen at Snake Spring, in the pass between the Granite Mountains and the Providence Mountains. The original spring of clear, cold water was in a natural cave beneath granite boulders, entirely shaded from sunlight and apparently unsuitable as a breeding site for toads. Water from the spring had been piped about 50 feet into the open, where it emptied into an uncovered concrete trough 14 feet long, 4 feet wide, and one foot deep, from which cattle and horses regularly drank. On one side, where the ground surface was within six inches of the rim of the trough, toads could gain access to the water, which was warmed by the sun and slightly alga laden. The temperature of the water on June 25, 1940, varied between 68°F. (in the morning, when the sunlight first struck the surface) and 82°F. (in midafternoon). On that date there were about 200 tadpoles in the trough, and 29 adult toads were found on the ground nearby on the evenings of that and the two preceding days. At Mitchell's and at Pachalka Spring spotted toads were

found in semiartificial situations. At the latter locality there were unusual concentrations of toads on boggy ground where water overflowed from a trough placed for livestock.

Tadpoles of two size groups were found on May 27, 1938, in the shallow, sun-warmed water that flowed out over granite rocks from Rock Spring. None could be found in the deeper and colder water in the tunnel from which the spring flowed. The total length of 44 of the smaller-sized tadpoles (measured after nearly two years in alcohol) varies between 8.3 and 13.5 mm., with an average of 11.2 mm. In seven of the larger-sized tadpoles the total length varies between 27.9 mm. and 37.7 mm. and averages 34.5 mm. This place was revisited on May 30, at which time the larger tadpoles were nearly metamorphosed. The more advanced of two individuals saved on that date had a head and body length of 15.1 mm. and a vestigial tail 6.2 mm. long.

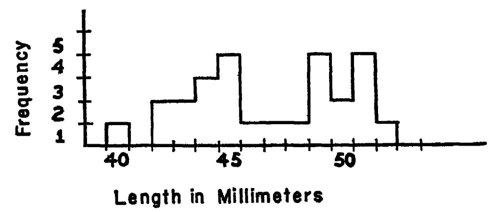


FIG. 18. Frequency distribution of head and body length of adult male spotted toads.

The 26 adult males in the series from Pachalka Spring, collected May 31, 1939, may be segregated into two size groups. Plotting of the individual measurements of head and body length gives a bimodal frequency polygon, as shown in figure 18. The series is about evenly divided between the larger and smaller size groups. The smaller group presumably consists of animals raised in the preceding spring. The adult females are larger than the males and have a similarly great range of variation in size, but there are too few females in our series to indicate segregation into definite size groups. The largest male we collected measures 51.9 mm., and the largest female 60.3 mm., in head and body length.

The reddish color of the warts on the back in preserved specimens is most pronounced in smaller individuals. In the series from Pachalka Spring all the males in the smaller size group (less than 45.5 mm. long) are conspicuously orange spotted, whereas, with one exception, the large males have dull gray or blackish dorsal warts.

As has been noted by Storer (1925:198) this species breeds rather late in the season, considering the arid nature of its habitat. In the Providence Mountains area the most dependable and widely distributed natural breeding sites are the small pools that remain in rocky depressions in the stream beds for a few weeks following the latest spring rains. The streams are strictly intermittent and usually carry large quantities of sand-laden water for not more than a few hours following heavy rains. Under these conditions eggs deposited early in the season would probably be washed away or buried by sediment in the floods following late storms.

REPTILES

Family GEKKONIDAE

Coleonyx variegatus variegatus (Baird)

Banded Gekko

Klauber (1932:120; 1945:153) found a banded gekko at Wheaton Spring in the daytime under a fallen yucca and reported one from Cima. A banded gekko, preserved in alcohol, was on exhibition at Mitchell's in June, 1938. It was said to have been caught in that vicinity.

Family IGUANIDAE

Dipsosaurus dorsalis dorsalis (Baird and Girard)

Crested Lizard

8 mi. W. Clark Mt., May 28; Kelso and 2½ mi. SW Kelso, June 19-23*; 8½ mi. NW Essex, June 10*. Total specimens, 12.

These large phytophagous lizards were found in the lowest and hottest parts of the area. All our records are from the creosote bush belt; the highest altitude represented is 3,200 feet. Near Kelso they were most abundant along the borders of a shallow wash and near the railroad bed, especially where large rocks had been used for fills. Northwest of Essex one was found beside a wash among creosote and catclaw bushes at the base of a rocky hill. We did not find them in sand dunes nor far from the washes on the sandy plains. They foraged most actively during the hottest part of the day. Near Kelso, on June 20, 1940, they were first seen at 8 a. m. and remained active until 1 p. m., by which time lizards of other kinds (*Callisaurus*, *Uma*, *Cnemidophorus*) had disappeared. In comparison with these other lizards, the crested lizards were slow in movement and easy to approach, although seemingly no less alert and capable of making rapid dashes for cover when alarmed. They were usually found at the bases of creosote bushes or running from one bush to the next. When frightened, they sometimes disappeared into kangaroo rat or ground squirrel burrows. The stomach of an adult male contained small flower heads of a yellow composite.

Crotaphytus collaris baileyi Stejneger

Collared Lizard

SE side Clark Mt., 5,600-5,700 ft., May 19-21*; Mescal Cave, May 18; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 22–June 3*; 2½ mi. SE Rock Spring, June 5; Mitchell's, June 10, June 25*. Total specimens, 14.

Collared lizards were found in unshaded rocky places at elevations between 4,500 and 5,700 feet. In May and June, 1938, individuals were frequently noted during midday sprawled on the tops of the largest boulders along the north side of Cedar Canyon (fig. 19). There they could sun themselves and also command an extensive view. They were never found far from the rock crevices that served as refuges and perhaps for this reason they were notably slower in their movements and less wary than were the more widely foraging leopard lizards.

The stomach of a young female collared lizard taken on June 10, 1938, at Mitchell's contained a fully grown *Uta stansburiana*. Stomachs of specimens from Cedar Canyon contained remains of large arthropods, chiefly grasshoppers.

Three adult males collected on May 23, 25, and 29, 1938, at Cedar Canyon exhibit the highly colored condition characteristic of the mating season. In each individual the anterior black collar is complete ventrally, there are large black groin patches, and blue-black areas extend over the throat and the sides of the belly. A female taken on May 30 contained two eggs, each 18 mm. long.

In 13 of the 14 specimens, two distinct rows of interorbital scutes separate

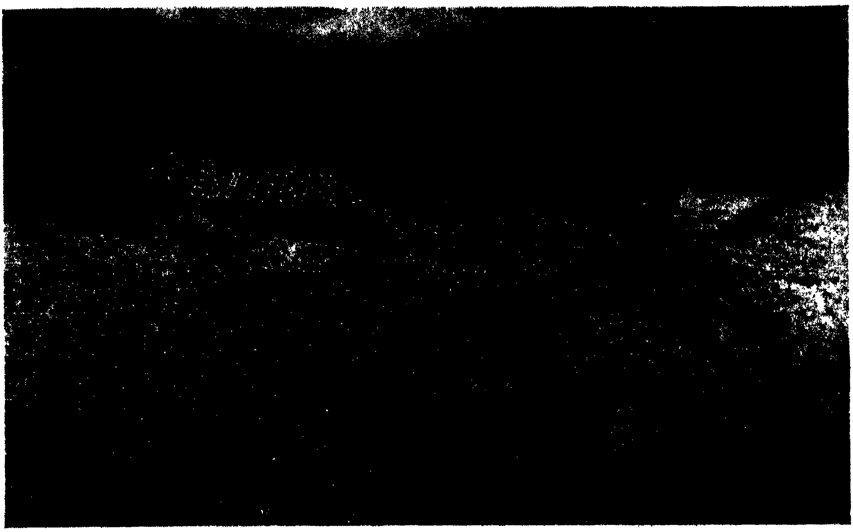


FIG. 19. Collared lizard on rock in sandy wash in Cedar Canyon. Photograph taken May 31, 1938.

the supraocular areas. In the remaining specimen, no. 26303, from Cedar Canyon, the interorbital scutellation is irregular; one of the scutes, though narrowing to sharp points on either side and partly divided by a submedian suture, completely bridges the interorbital area. The largest male collected has a total length of 308 mm., the largest female, 280 mm.

Gambelia wislizenii wislizenii (Baird and Girard)
Leopard Lizard

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,000 ft., May 27*; S side Clark Mt., 5,400 ft., May 20*; 2 mi. NNE Cima, May 12-19*; 2 mi. E Cima, May 12*; Cedar Canyon, May 22–June 3*; 2 mi. ESE Rock Spring, June 5*; pass between Granite Mts. and Providence Mts., June 11*; 1½ mi. WSW Hidden Hill Mine, June 26. Total specimens, 13.

Leopard lizards were found at elevations between 3,300 and 5,400 feet, chiefly on the upper parts of the alluvial fans, where the terrain was gently sloping, the soil sandy, and the vegetation consisted mainly of isolated shrubs. They were frequently seen about the bases of bushes or running across the intervening openings in the Joshua tree forest near Cima in May, 1938. None

was seen climbing in trees or on rocks, but on at least one occasion on the south side of Clark Mountain, a frightened individual was seen to scurry rapidly through the lower branches of a shrub. Where there were both rocks and sand, as at Cedar Canyon, leopard lizards and collared lizards occupied mutually exclusive territories, the former on sandy areas, the latter on rocks.

Leopard lizards were distinctly predatory. Near Hidden Hill Mine, on the morning of June 26, 1940, one was seen dragging a limp, but not yet dead, gridiron-tailed lizard (*Callisaurus draconoides*) across a road. A male leopard lizard taken near Cima on May 13, 1938, had recently swallowed a fully grown *Uta stansburiana*. A large female taken on the north side of Clark Mountain on May 27, 1939, had the remains of a young pocket mouse (*Perognathus formosus*) in its stomach. Other individuals had eaten large insects, chiefly fully grown grasshoppers. There were several large seeds with pulpy, orange-colored coats in the stomach of a female taken on June 11, 1938, in the pass between the Granite Mountains and the Providence Mountains; this was the only evidence that plant material was being eaten.

The course of the breeding season, as indicated by the stage of development of eggs and the presence of red breeding color on adult females taken, is indicated in the following summary:

May 12, 1938. No. 26308. Breeding color absent; diameter of largest egg, 2.5 mm.
May 20, 1939. No. 28427. Breeding color absent; diameter of largest egg, 6.0 mm.
May 27, 1939. No. 28425. Breeding color present; 6 eggs, all about 18 mm. long.
May 28, 1939. No. 28426. Breeding color absent; diameter of largest egg, 5.3 mm.
June 11, 1938. No. 26315. Breeding color present; eggs apparently recently laid, none in body; cloaca swollen and partly everted.

Whitish dorsal cross-bands are present on all the specimens except the three largest females. The total length of the largest male is 304 mm., of the largest female, 339 mm.

Sauromalus obesus (Baird)
Chuckwalla

5 mi. SW Ivanpah, May 15*; Colton Well, June 7; Snake Spring, June 23-24*; 8½ mi. NW Essex, June 10*. Total specimens, 4.

Chuckwallas, like crested lizards (*Dipsosaurus dorsalis*), were found chiefly at low elevations, appeared only during the hottest parts of the day, and were feeding only on plant material; but, whereas the crested lizards inhabited the sandy washes and bordering flats, chuckwallas were restricted to cliffs and talus slopes. For example, northwest of Essex a chuckwalla was found on one of the largest boulders in the talus below a basaltic cliff and a crested lizard was less than a hundred yards away on sandy soil among creosote bushes. These two species bear the same ecologic relationship to one another as do the collared lizards and the leopard lizards (*Crotaphytus collaris* and *Gambelia wislizenii*); in each instance the two species have essentially the same food requirements, but they do not compete because one is specialized for living among rocks, the other on sandy soil.

The highest elevation at which a chuckwalla was found was 4,500 feet, 5

miles southwest of Ivanpah, where one was taken on May 15, 1938, on a ledge of a sun-facing granite cliff near the bottom of a deep canyon. This was at the lower edge of the piñon belt. In the pass between the Granite Mountains and the Providence Mountains, chuckwallas were occasionally seen on grayish white granite boulders. In general, they were wary and difficult to approach, taking refuge in rock crevices at the first sign of danger.

Callisaurus draconoides gabbii Cope

Gridiron-tailed Lizard

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,000 ft., May 26*; Pachalka Spring, Oct. 2; ½ mi. NE Barnwell, May 30*; 5 mi. SW Ivanpah, May 15*; 1½ mi. SE Rock Spring, June 5*; 2½ mi. SW Kelso, June 18-23*; Colton Well, June 7-8*; Mitchell's, June 9-10*; pass between Granite Mts. and Providence Mts., June 11*; 1½ mi. SW Hidden Hill Mine, June 26*; 8½ mi. NE Essex, June 10*. Total specimens, 73. Klauber (1932:121) records specimens from Wheaton Spring.

Gridiron-tailed lizards were found in greatest abundance at elevations below 3,500 feet, where they frequented sandy and gravelly areas among creosote bushes, catclaws, and desert willows. At higher elevations, up to 5,000 feet, they were less abundant and were restricted mainly to sandy flats and the beds of washes. We found no lizards of this species in the piñon belt and few among the Joshua trees.

Food found in the stomachs of specimens collected in the latter part of May indicates a mixed diet of animal and plant materials at that season. Beetles, flies, young grasshoppers, ticks, and various insect larvae make up most of the animal remains. The plant material includes small, beanlike seeds with fleshy, orange-colored capsules.

A large female, limp and nearly dead, was dragged across a road in front of our car by a leopard lizard (*Gambelia wislizenii*) scarcely larger than itself, near Hidden Hill Mine on June 26, 1940.

Well-developed eggs, more than 5 mm. long, were found in females collected on May 28 and on subsequent dates up to June 19; other females collected on June 19 contained partly developed eggs that probably would have been laid in the same season. The largest eggs, 15 mm. long, were in a specimen collected June 7. Apparently no young-of-the-year were out in May and June. On October 2, these lizards were active at Pachalka Spring, 4,800 feet.

Uma scoparia Cope

Mohave Uma

All our observations on umas were made at about 2,100 feet altitude in the sand dune country southwest of Kelso, between June 18 and 22, 1940 (32 specimens). We found them at no other place in the Providence Mountains area. They occurred, without exception, in places where fine sand, unmixed with rocks and not hard packed, had been deposited by wind. Where this specialized habitat was best developed no other lizards were present. Tracks were seen on the high and barren ridges of the large dunes, but most of the individu-

als were in the basins among the smaller dunes, where a kind of harsh, green grass and a few small shrubs provided shade; here also the openings of ground squirrel and kangaroo rat burrows provided refuge places. On the plains marginal to the dunes the sand was less subject to being shifted by the winds and supported a sparse growth of creosote bush and grass (*Oryzopsis hymenoides*). There the sand lizards occurred in smaller numbers, in company with gridiron-tailed lizards (*Callisaurus*), whip-tailed lizards (*Cnemidophorus*), crested lizards (*Dipsosaurus*), and desert tortoises (*Gopherus*). In the bed of a shallow wash umas were found only where fine sand had been deposited by wind to the leeward of water-cut banks and clumps of desert willows.

These lizards were usually first seen as they started off at a run from the bare sand at the observer's feet. They followed a somewhat erratic course, making sharp-angled turns at high speed, and stopping abruptly, often just out of sight behind a bush or a ridge of sand. Sometimes they ran into the openings of ground squirrel or kangaroo rat burrows; at other times they dived beneath the surface of the loose sand. Only rarely did they stop within sight. The mottled dorsal color pattern served to make them almost invisible against the sand.

It was noted that faint tracks of the forefeet were left in the sand when the lizards were moving slowly, but at a rapid run only the hind feet left tracks. A spray of sand was kicked up when sharp turns were made. In running, the tail was held up, but its tip was not curved forward.

The stomachs of two large males contained, beside grains of sand and numerous parasitic round worms, ants, beetles, small seeds, and leaves. All the large females contained well-developed eggs.

Urosaurus graciosus Hallowell

Long-tailed Uta

This species, like the foregoing, inhabited the lowest and hottest part of the Providence Mountains area. It was found only near Kelso, at 2,100 feet altitude. A total of six individuals was seen, and three of them, two males and a female, were collected. Although we watched for lizards of this species at all times of day and in a variety of habitats, we found them only late in the evening along a shallow wash bordered by desert willows and creosote bushes.

Their climbing propensities are illustrated by the following observations. On the evening of June 19, 1940, a female was found on a slender limb among relatively dense foliage on the shady side of a desert willow. On the following evening two individuals were seen dashing to the base of a creosote bush, where they jumped up to branches about four inches from the ground and ran nimbly along small branches. On June 21, at about 7:45 p. m., a male was found, about two feet from the ground, on a box in our camp; it was unafraid and allowed itself to be picked up by hand. On the evening of June 22, one was seen in a small, dry bush, and another, a male, in a dense clump of desert willows.

The stomachs of two of the specimens collected contained remains of small beetles. The female taken on June 19 contained eggs 6 mm. long.

Uta stansburiana stejnegeri Schmidt

Ground Uta

8 mi. W Clark Mt., May 28; N side Clark Mt., 5,000-5,400 ft., May 26-27*; Pachalka Spring, Oct. 2*; S and SE sides Clark Mt., 5,000-6,300 ft., May 19-22*; Mescal Cave, May 18; 2 mi. NNE Cima, May 12-19*; 5 mi. SW Ivanpah, May 15; Purdy, April 26; Cedar Canyon, May 24–June 3*; Government Holes, May 27; 2 mi. ESE Rock Spring, June 4-5*; 5 mi. NE Granite Well, Dec. 31*; Colton Well, June 7-8*; Mitchell's, June 10; Snake Spring, June 23-25*; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 79.

Utas of this species were abundant in a variety of situations between 3,200 and 6,300 feet altitude in May and June. A young male collected northeast of Granite Well on December 31, 1937, is our only winter record of a lizard of any species in the area. Most individuals were in places where boulders, rock

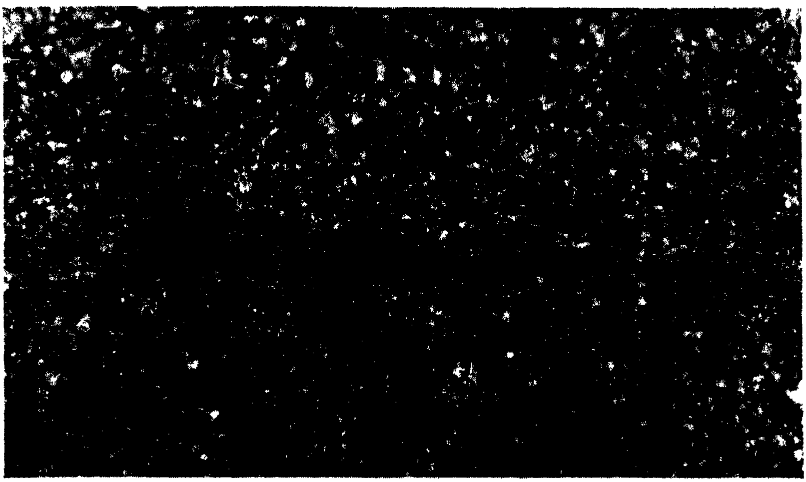


FIG. 20. Ground uta in natural habitat in wash in Cedar Canyon. Photograph taken May 27, 1938.

ledges, or woody plants provided crevices in which these small-bodied lizards (fig. 20) could find refuge. We did not find them far from rocky places except in the Joshua tree belt.

Several were seen on May 13, 1938, between 9 and 11 a. m., near the base of a rocky hill two miles east of Cima. Most of them were on the ground beneath spiny, matlike tangles of dead branches and debris at the bases of shrubs. Usually they were first seen as they ran across open ground from the base of one shrub to another. At least nine individuals were seen between 3 and 5 p. m. on the same day in the Joshua tree forest north-northeast of Cima. They were perched quietly in the slanting rays of the late afternoon sun, from one to three feet above the ground on dead Joshua tree logs, the only prominent features in the landscape except bushes and living Joshua trees. When disturbed, these utas dropped quickly to the ground and disappeared into the surrounding litter of bark and branches. There was only one uta in each such situation, and almost every log was occupied. Apparently the lizards were

sunning themselves, but perhaps they also found this sun-warmed surface the best place in which to forage for small insects in the late afternoon. The stomachs of several specimens contained various kinds of small arthropods. There was no plant material present.

These small and abundant lizards served as food for certain of the larger predatory reptiles. An adult female uta was found in the stomach of a leopard lizard taken near Cima on May 13, 1938, and there was another adult in the stomach of a collared lizard taken at Mitchell's on June 10. When the young-of-the-year are abroad later in the season, the utas are probably preyed upon to an even greater extent. On June 24, 1940, two small utas were in the stomach of a red racer taken in the pass between the Granite Mountains and the Providence Mountains.

A posturing reaction of raising the body high above the ground and arching the back and tail in response to the presence of another lizard was noted (by Rodgers) in Cedar Canyon on May 25, 1938. A female uta assumed this posture as a whip-tailed lizard moved slowly past it in short, jerky runs. Later a male uta, in moving cautiously away from the observer, came close to a female of its own species and, apparently forgetting for the moment its fear of pursuit, exhibited the same posturing reaction and approached the female, which left the vicinity.

All the specimens we collected between May 13 and June 11 had head and body lengths of more than 40 mm., and many of the females contained large eggs. The season's brood of young is represented by two specimens taken on June 24, one of which had a head and body length of 21 mm. The one winter-taken specimen, collected December 21, was of less than adult size, having a head and body length of 37.8 mm.; evidently it was hatched in the previous season.

Sceloporus magister Hallowell
Spiny Lizard

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,000 ft., May 26-27*; Pachalka Spring, Oct. 2; Mescal Spring, May 30*; 2 mi. NNE Cima, May 13*; 2 mi. E Cima, May 13*; 3 mi. SE Cima, May 20*; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 20-29*; 2 mi. ESE Rock Spring, June 4-5*; Colton Well, June 7-8*; Snake Spring, June 23-24*; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 28. Recorded from Wheaton Spring by Klauber (1932:122).

Spiny lizards were present at elevations between 3,200 and 5,000 feet. Usually they were found along the bases of hills and at the edges of sandy washes where there were rock ledges or large boulders. For example, along the north side of Cedar Canyon they were regularly seen perched on the tops of outlying boulders up to 8 feet high, or scuttling across the sandy areas from one such boulder to another (fig. 21). East of Cima a large male was seen on the top of a prominent boulder on a low rocky hill among Joshua trees and cholla cactus.

In places where there were no large rocks, other objects were used for observation posts and for shelter. In the nearly level area north-northeast of Cima a young individual was found perched on the most elevated part of a

crooked Joshua tree log, and on the north side of Clark Mountain an adult male was seen ten feet above the ground in a Joshua tree.

The local distribution of this species was found to complement that of *Sceloporus occidentalis*, the former occupying the area below the piñon belt, the latter occurring for the most part among the piñons. At Cedar Canyon, just at the lower edge of the piñons, both species were abundant, but whereas *occidentalis* inhabited the piñon-shaded ledges and the north- and east-facing walls of the narrow side canyons, *magister* lived among the unshaded rocks of the hotter south-facing wall of the main canyon.

In marked contrast to fence lizards, spiny lizards were wary and exhibited

FIG. 21. Spiny lizard on granite rock in Cedar Canyon. Photograph taken May 29, 1938.

little curiosity. They often disappeared into crevices beneath rocks while the observer was 50 feet or more away.

Food found in the stomachs of specimens taken in May and June indicates a mixed diet of small arthropods and plant material.

Each of the five adult females taken between May 22 and June 11 contained developing eggs, the smallest being 4.4 mm., the largest 13.2 mm. in length. Among the 28 specimens collected between May 13 and June 24, three males and three females are obviously young. The head and body lengths of the young males are, respectively, 69, 71, and 77 mm.; of the young females, 51, 54, and 60 mm. In the adults this measurement ranges from 84 to 111 mm.

Sceloporus occidentalis biseriatus Hallowell
Fence Lizard

N side Clark Mt., 5,000 ft., May 26*; NW side Clark Mt., 7,300 ft., May 20*; SE side Clark Mt., 5,600-6,300 ft., May 18-21*; Mescal Cave, May 18*; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 24–June 1*; 2½ mi. SE Rock Spring, June 5; Snake Spring, June 24-25*. Total specimens, 29.

In the Providence Mountain area, fence lizards are restricted to elevations above 4,000 feet. Except for an individual seen at the top of a bare, lava-capped

outcropping 2½ miles southeast of Rock Spring, this species was found only at localities within the piñon belt. Near the lower border of the piñons, as in Cedar Canyon, the range of *Sceloporus occidentalis* overlaps that of *Sceloporus magister*, and there the two species occupy mutually exclusive habitats (see account of *magister*). A specimen taken at 7,300 feet altitude on Clark Mountain indicates that fence lizards probably range to the summits of the highest peaks. *Sceloporus occidentalis* is restricted to higher zonal and altitudinal levels than is any other lizard species in the area. Like the chipmunk (*Eutamias panamintinus*) and the striped racer (*Coluber taeniatus*), in the Providence Mountains it reaches its southernmost limit as far as the eastern Mohave Desert region is concerned.

Usually fence lizards were seen in places that were shaded during the hottest part of the day, such as ledges beneath piñons or steep canyon sides. They were relatively unwary, allowing observers to approach closely without becoming alarmed.

The adult females collected between May 15 and May 31 contained developing eggs up to 13 mm. long. The food found in the stomachs of some of the specimens consists entirely of the remains of small arthropods.

Phrynosoma platyrhinos platyrhinos Girard
Desert Horned-toad

8 mi. W Clark Mt., May 26*; 3 mi. N Ivanpah, April 24*; 5 mi. SW Ivanpah, 3,500-4,000 ft., May 15*; 2 mi. NNE Cima, May 14*; Cima, May 15*, June 1*; 3 mi. SE Cima, May 20*; 2 mi. ESE Rock Spring, June 4; 2½ mi. WSW Hidden Hill Mine, June 10*. Total specimens, 11.

Horned-toads were found in sandy and gravelly areas at altitudes between 3,300 and 4,700 feet. All the localities of occurrence are in the low valley bottoms or on the gently sloping alluvial fans. At the upper edges of the alluvial fans, as southwest of Ivanpah and west-southwest of Hidden Hill Mine, horned-toads were on soil that was rocky and cut up by shallow washes. We did not find this species among the piñons or in the rocky canyons at the bases of the mountains.

The eleven specimens taken include nearly all the horned-toads seen by us in the area. The species is apparently evenly distributed over the greater part of the area we studied, but it is nowhere abundant. We found no colonies, or even pairs; each individual was solitary.

Two adult males were found at about 4 p. m. on May 14, 1938, at different places in the Joshua trees northeast of Cima. Each was about 18 inches above the ground on the end of a limb projecting from a dead Joshua tree log, apparently basking in the late afternoon sun. At other places horned-toads were seen in midday crossing the road in front of our car and scurrying for shelter beneath spreading bushes.

The stomachs of two specimens contained small arthropods, chiefly ants, and numerous pieces of sand that may have been swallowed accidentally. Horned-toads breed relatively late in the season. The diameter of the largest egg in a female taken on April 24, 1920, is 2.8 mm.; in one taken on May 20,

1938, it is 2.9 mm. The largest eggs, 5.5 mm. in diameter are in a female taken on June 10, 1938. Two young males, taken on May 15, 1938, and May 26, 1939, measure, respectively, 55 mm. and 61 mm. in head and body length; they probably represent the broods of the seasons preceding those in which they were collected.

Family XANTUSIIDAE

Xantusia vigilis Baird

Night Lizard

SE side Clark Mt., 5,000 ft., May 22*; Purdy, April 26*; Cedar Canyon, May 26*. Total specimens, 7. Recorded by Klauber (1932:123) from Mountain Pass and Wheaton Spring; by Van Denburgh (1922:479) from Bonanza King Mine.

Night lizards were found by us only under the loose bark of dead and fallen Joshua trees and in the surrounding debris (fig. 22). All our records are from

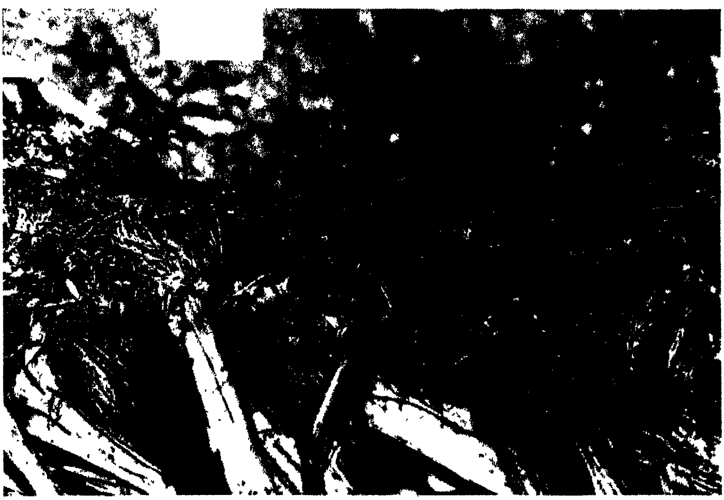


FIG. 22. Night lizard on rotten log of Joshua tree, under bark and leaves of which it had sought cover. Photograph taken May 27, 19.8, at Cedar Canyon.

elevations between 4,500 and 5,050 feet. Klauber (1939:98) gives the elevation for specimens taken at Mountain Pass as 5,190 feet, and the same author (1932:123) says that there they were found more frequently under the trunks of Spanish dagger (*Yucca mohavensis*) than under Joshua trees.

Thorough search of the remains of a prostrate dead Joshua tree in an area 10 feet in diameter in Cedar Canyon on May 26, 1938, revealed the presence there of four night lizards and one spotted night snake (*Hypsiglena ochrorhyncha*). Three of the lizards were in the debris on the ground, and the fourth was under the loose bark of a limb. On the southeast side of Clark Mountain, a prolonged search on May 22, 1939, resulted in capturing one individual and seeing another beneath fallen Joshua tree limbs. One of the lizards was under loose bark.

Family Teiidae

Cnemidophorus tesselatus tesselatus (Say)

Whip-tailed Lizard

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,000-5,500 ft., May 24-31*; Pachalka Spring, June 1*; S and SE sides Clark Mt., 4,800-6,300 ft., May 17-22*; Mescal Spring, May 30*; Mescal Cave, May 18*; 5 mi. SW Ivanpah, May 15; 2 mi. NNE Cima, May 13-16*; 5 mi. SE Cima, May 25*; Cedar Canyon, May 18–June 4*; Rock Spring, May 27*; 2 mi. ESE Rock Spring, June 5*; Kelso, June 21*; 2½ mi. SW Kelso, June 19-23*; Colton Well, June 7-8*; Mitchell's, June 9-10*; Snake Spring, June 24-25*; pass between Granite Mts. and Providence Mts., June 11*; 8½ mi. NW Essex, June 10*. Total specimens, 231.

Whip-tailed lizards, widely distributed in the Providence Mountains area, inhabited sandy slopes and washes, in the vicinity of scattered bushes. Our records indicate an altitudinal range of 4,200 feet between 2,100 feet (2½ miles southwest of Kelso) and 6,300 feet (southeast side of Clark Mountain).

At Cedar Canyon they were most numerous in places where bushes were abundant and the soil was sandy and not hard packed (fig. 23). A few individu-

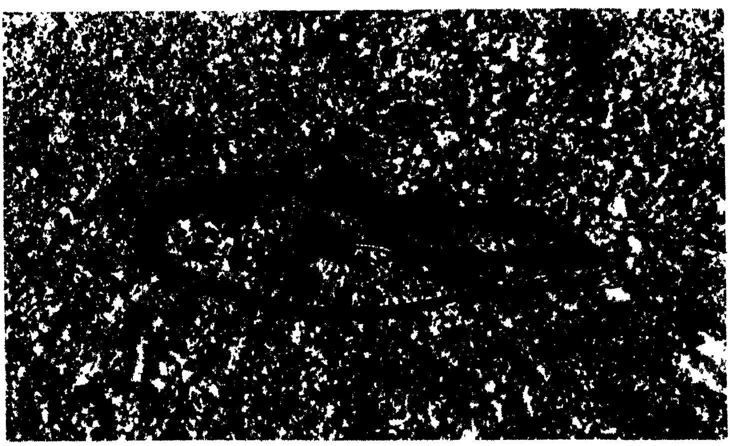


Fig. 23. Whip-tailed lizard in sand of desert wash at Cedar Canyon. Photograph taken May 25, 1938.

als were seen foraging over the litter beneath piñons at the sides of the canyon.

Conditions seemed most favorable for this species on the upper parts of the broad alluvial fans at the bases of the mountains. On the south side of Clark Mountain in 1939, only a few whip-tailed lizards were found at the uppermost limit of their range, around 6,300 feet, where conditions were apparently too rocky. Greater numbers were seen lower on the mountain, where the washes widened and scattered bushes were more abundant. At 3,300 feet altitude on the floor of the valley 8 miles west of Clark Mountain, this species was relatively scarce and was outnumbered by gridiron-tailed lizards (*Callisaurus*).

Unlike most other kinds of lizards in the area, whiptails moved incessantly over the ground about the bases of the bushes and climbed up into the bushes themselves in foraging, actively seeking out prey, rather than lying in wait and dashing out after it as did the collared and spiny lizards. Two stomachs

of whip-tailed lizards contained grublike insect larvae about an inch long. Lizards that were digging numerous shallow pits in the sandy soil at Cedar Canyon on May 31, 1938, were probably in search of food of this kind. Near Colton Well, several individuals were seen foraging in shrubs, climbing with ease through the finer branches.

Whip-tailed lizards were generally most conspicuous during the morning hours. Very few were found abroad in the afternoons. In their daily cycle of activity they thus avoided direct competition with the skinks (*Eumeces gilberti*), which occupied the same habitat and foraged in a similar manner but confined their periods of greatest activity to the afternoons.

Pairs of whip-tailed lizards were seen commonly in late May and in June. At Cedar Canyon on May 28, at Colton Well on June 7, and near Kelso on June 19, males were in close attendance on females, following them persistently and chasing away other males. Many of the females collected in this period contained large eggs, evidently nearly ready to be laid. Copulation was observed at Cedar Canyon on May 29.

An accident that would problably have proved fatal to the lizard involved was observed at 1½ miles southwest of Mescal Spring on May 18, 1938. At about noon a small female whip-tailed lizard, 50 mm. in head and body length, was seen thrashing vigorously about on a sand bar in the narrow bed of a small rock-walled canyon. The lizard was held fast by the terminal two inches of its tail, which was buried in damp sand. The tail was twisted, but, in spite of the lizard's violent efforts to escape, it did not break off. Apparently the lizard had burrowed into the dry sand on the preceding day, and a light thunder shower that fell that afternoon had dampened and packed the sand about it.

Family SCINCIDAE

Eumeces gilberti rubricaudatus Taylor
Skink

Pachalka Spring, May 31*; SE side Clark Mt., 5,800-7,300 ft., May 18-21*; Mescal Cave, May 18; Cedar Canyon, May 22-31*; 2 mi. ESE Rock Spring, June 5*. Total specimens, 25.

Where the two species occurred together, skinks were found in almost the same environment as whip-tailed lizards (*Cnemidophorus*), but skinks appeared to prefer more rocky situations and were more restricted to relatively moist places such as the ground under thickets, in ravines and on the banks of washes. Our specimens came from elevations between 4,700 feet (near Rock Spring) and 7,300 feet (southeast side of Clark Mountain). Skinks were warier and more difficult to observe than whip-tailed lizards.

At Pachalka Spring skinks were exceptionally numerous, perhaps because of the favorable environment provided by the seepage area from an overflowing spring which had locally stimulated the growth of grass and brush thickets. On the afternoon of May 31, 1939, five skinks were caught there in three hours in mouse traps baited with anise-seed oil, and another was found moving about in the litter beneath a large cottonwood tree.

At Cedar Canyon skinks lived in the area of more abundant vegetation along the north side of the wash. There they found a mat of leaf litter and loose,

fairly damp soil beneath large bushes. Some were seen in crevices at the base of the rocky canyon wall nearby (figs. 24 and 25), and one was in debris beneath a Joshua tree.

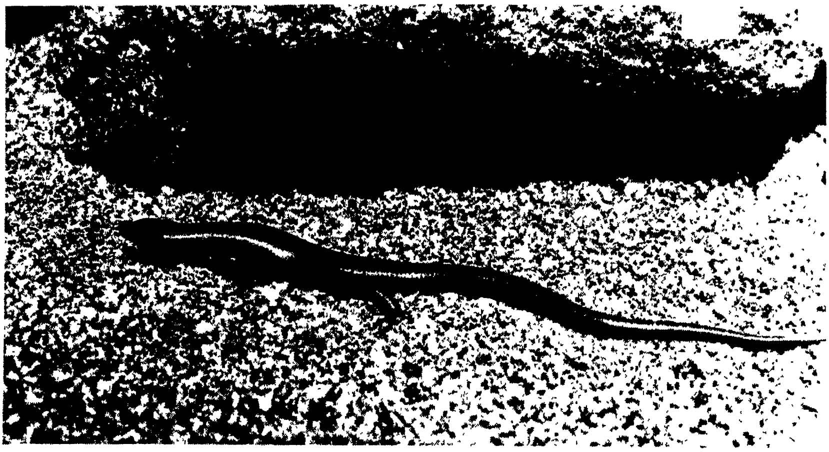


Fig. 24. Skink captured in Cedar Canyon. Photograph taken May 31, 1938.

Fig. 25. Habitat of skink among rocks, Spanish bayonet, and cacti in Cedar Canyon. Photograph taken May 29, 1938.

In our work in the Providence Mountains area we found no skinks abroad in the morning hours. The maximum activity took place in late afternoon, within the last 3 or 4 hours before sunset.

For taxonomy, see Rodgers and Fitch (1947:204).

Family BOIDAE

Lichanura roseofusca gracia Klauber

California Boa

Only one boa was encountered, a large male found near Mitchell's at about 6 a. m., on June 10, 1938. It was lying across a path on a steep, rocky slope. This snake was extremely sluggish and, when picked up, made no attempt to bite or escape.

The color pattern of this individual (no. 26648) agrees closely with that described by Klauber (1931:308) for the subspecies *gracia*, except that the reddish stripes are only faintly contrasted with the ground color and are not darker along their edges. This form is recorded from the Providence Mountains by Klauber.

Family COLUBRIDAE

Coluber flagellum frenatum (Stejneger)

Red Racer

S side Clark Mt., 4,600 ft., May 23*; 2 mi. NNE Cima, May 13*; Snake Spring, June 24*. Total specimens, 3.

The three widely separated localities at which red racers were found are all near the upper edges of alluvial fans, below the piñon belt, and near the rocky bases of the mountains.

A large female found near Cima on the morning of May 13, 1938, was in the Joshua tree belt on gently sloping gravelly soil, about a mile from the nearest rocky hills. The snake was discovered just after it had swallowed three young desert sparrows (*Amphispiza bilineata*) from a nest in a low bush. A somewhat smaller male red racer, found on June 24, 1940, near Snake Spring was in a wash bordered on the west by a steep, rocky slope and on the east by a creosote bush flat. Its stomach contained two young ground utas (*Uta stansburiana*).

Coluber taeniatus taeniatus (Hallowell)

Striped Racer

N side Clark Mt., 5,000 ft., Oct. 3*; Clark Mt., 7,500 ft., May 17*; SE side Clark Mt., May 20–22*. Total specimens, 4.

This relatively high-zone species was encountered only in the piñon belt on Clark Mountain. One individual was found within 400 feet of the summit. Each of two females collected at 6,300 feet altitude in 1939 contained large eggs, measuring 27 mm. in length in a specimen taken May 20, and 40 mm. in one taken May 22.

Salvadora hexalepis hexalepis Cope

Patch-nosed Snake

At Cedar Canyon patch-nosed snakes (fig. 26) were found at 5,000 feet altitude near the bottom of one of the small side canyons in a mixed association of sagebrush, sage (*Salvia*), currant bush, and piñon. Near Colton Well,

at 3,300 feet, one was seen in a broad, shallow wash bordered by creosote bush flats. Klauber (1932) records specimens taken in association with brush and rocks at Mountain Pass and Wheaton Spring, both of which are above 4,000 feet. The records from this area indicate a slightly higher altitudinal and zonal range than Bogert (1939:193) attributes to this subspecies.

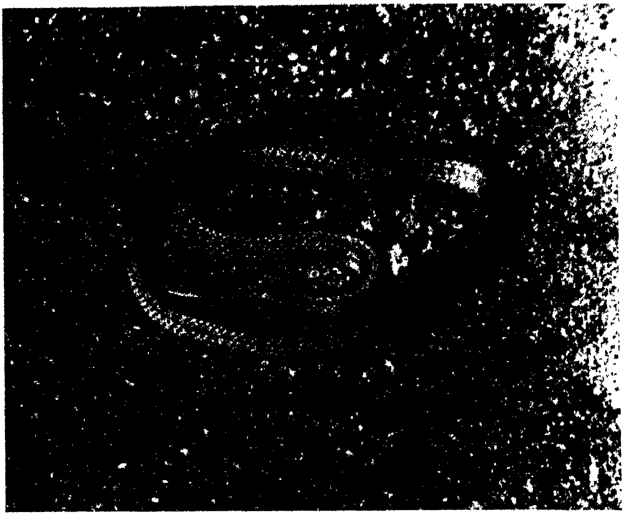


FIG. 26. Patch-nosed snake captured in Cedar Canyon. Photograph taken May 31, 1938.

Two specimens from Cedar Canyon are females, both containing eggs. In one collected May 31, 1938, the eggs are 26 mm. long; in the other, collected June 4, they are 34 mm.

Pituophis catenifer deserticola Stejneger
Gopher Snake

N side Clark Mt., 5,000 ft., May 27*; 3 mi. N Cima, May 24*; Government Holes, May 27*; Rock Spring, June 4*. Total specimens, 4. Recorded from Mountain Pass by Klauber (1932:125).

All our records of gopher snakes are from elevations between 4,000 and 5,000 feet, in the rocky areas along the bases of the mountains.

On the morning of May 27, 1939, on the north side of Clark Mountain, a male gopher snake 850 mm. long was found in the act of killing by constriction a young antelope ground squirrel. The snake had two coils wrapped around the squirrel.

The largest gopher snake we found is a male measuring 1,420 mm. (about 56 inches) in total length. It was taken in a sandy wash at 4,800 feet altitude near Rock Spring.

Lampropeltis getulus boylii (Baird and Girard)
King Snake

A large male king snake was found in the late afternoon of June 1, 1938, at 5,000 feet altitude on the north side of Cedar Canyon. It was crawling slowly

across a mat of pine needles in the shade of a dense piñon. There were numerous rock ledges in the vicinity. Recorded from the Providence Mountains by Van Denburgh (1922:754).

Rhinocheilus lecontei clarus Klauber
Long-nosed Snake

A long-nosed snake (fig. 27) was given to us in 1938 by Mr. A. H. Thomas, who had found it in a basement on his ranch in the Joshua tree belt 5 miles southeast of Cima, at 4,300 feet altitude. The snake was a female. It contained eggs 18 mm. long. Klauber (1941) lists this specimen as *clarus* but reports *R. l.*

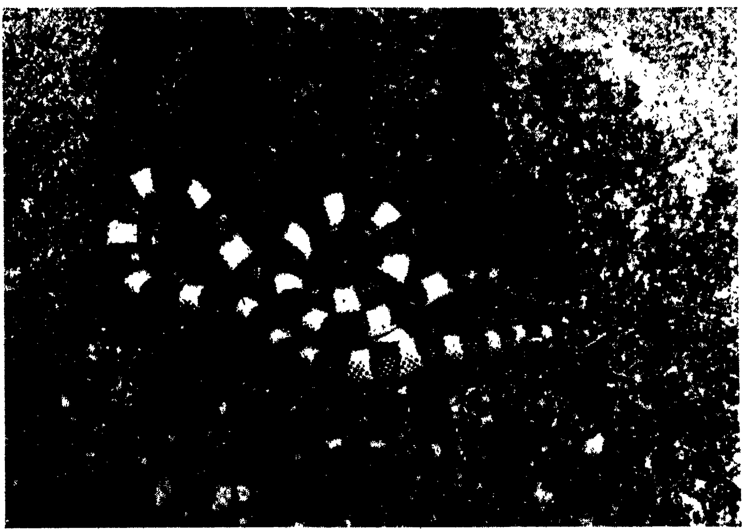


FIG. 27. Long-nosed snake captured 5 miles southeast of Cima.

lecontei from Mountain Pass. This is apparently an area where both types of this snake occur; it is not known which predominates in the population. At Mitchell's we saw the skins of two long-nosed snakes that had been caught near there.

Sonora miniata linearis Stickel
Ground Snake

A preserved specimen of this snake, with a broad, salmon-colored median dorsal stripe bordered by gray, was shown to us at Mitchell's on June 9, 1938. It was said to have been collected there.

Hypsiglena ochrorhyncha Cope
Spotted Night Snake

A spotted night snake 265 mm. long was found in the daytime in a hole in moist sand under a dead Joshua tree limb, at 5,000 feet altitude in Cedar

Canyon on May 26, 1938 (fig. 28). Four night lizards (*Xantusia vigilis*) were found nearby.

Family Crotalidae

Crotalus cerastes cerastes Hallowell

Sidewinder

8 mi. W Clark Mt., May 25 (1 specimen); 2½ mi. SW Kelso, June 20 (tracks).

Evidence of the presence of sidewinders was found only in the low valley bottoms, in the creosote bush belt.

A young individual, 253 mm. in total length, was found at 3,300 feet altitude, 8 miles west of Clark Mountain on the evening of May 25, 1938. On

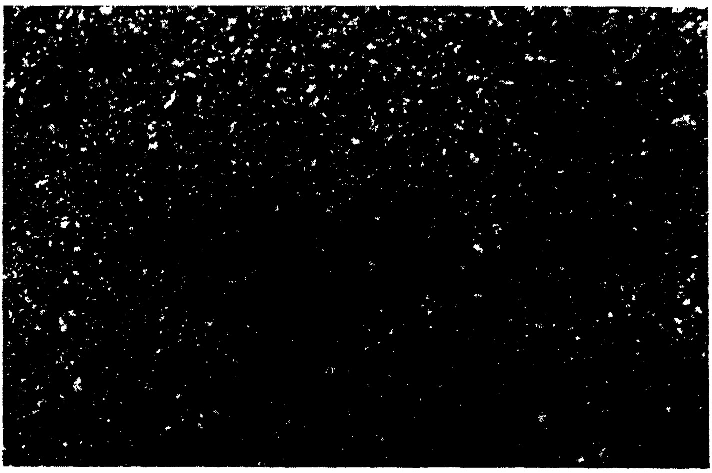


Fig. 28. Spotted night snake taken from a hole in damp sand in Cedar Canyon. Photographed May 27, 1938.

June 20, 1940, several series of the oblique S-shaped tracks made by a sidewinder were seen in the early morning on the sloping side of a bank of wind-blown sand in a wash at 2,100 feet altitude 2½ miles southwest of Kelso. In the fine sand the imprints of the individual ventral plates could be clearly seen.

Crotalus scutulatus (Kennicott)

Mohave Rattlesnake

Valley Wells, June 1*; 2 mi. NNE Cima, May 17*; 3 mi. SE Cima, June 1*; Cedar Canyon, May 26*. Total specimens, 4.

Rattlesnakes of this species were encountered in open, gravelly and sandy areas at altitudes from 3,700 to 4,950 feet. Specimens from near Cima were in the Joshua tree belt on the broad alluvial fans (fig. 29). One from Cedar Canyon was in a broad, sandy wash.

Our observations indicate mutually exclusive habitat preferences for the three species of rattlesnakes in the area: *C. cerastes* inhabits the low, hot valley bottoms, preferably where the soil is of the fine, wind-deposited type; *C.*

mitchellii inhabits the rocky outcroppings, talus, and deep canyons along the bases of the mountains; and *C. scutulatus* ranges over the intervening area of gently sloping alluvial fans, where the soil is coarse, fairly firmly packed, and cut by numerous shallow washes. The range of *C. scutulatus* is locally more extensive than are those of the other two species.

A small male *C. scutulatus* (348 mm. long) found in Cedar Canyon on May 26, 1938, had half-swallowed an adult pocket mouse (*Perognathus longimembris*), which was regurgitated when the snake was disturbed. This snake

FIG. 29. Mohave rattlesnake coiled in shade by dead limb of Joshua tree, 2 miles north-northeast of Cima. Photograph taken May 14, 1938.

had apparently shed its skin recently. Remains of a whip-tailed lizard (*Cnemidophorus tesselatus*) were found in the stomach of a specimen taken on May 17, 1938, near Cima.

Crotalus mitchellii pyrrhus (Cope)
Speckled Rattlesnake

Cedar Canyon, May 24–June 3*; Colton Well, June 8*, Oct. 6*; Mitchell's, June 9. Total specimens, 5. Recorded from Gilray Canyon, Providence Mts., by Klauber (1936:159).

These large, thick-bodied rattlesnakes were encountered in the rocky canyons and slopes at elevations between 3,200 and 5,150 feet along the bases of the mountains.

A large male was found in midafternoon of May 28, 1940, in the sandy bed of a small canyon tributary to Cedar Canyon. It was only a few yards from high rock ledges and a boulder-strewn slope. Its stomach contained the remains of an antelope ground squirrel. Another snake taken on June 3 in the same vicinity had eaten an antelope ground squirrel and a white-footed mouse (*Peromyscus truei*). A snake, taken at Colton Well on October 6 on a rocky slope, had also eaten an antelope ground squirrel.

The approximate line of intergradation between the two subspecies, *stephensi* and *pyrrhus*, as indicated by Klauber (1936:163), transects the Providence Mountains area. All our specimens were taken in the southern part of the area, hence falling within the geographic range of *pyrrhus*, to which race the

specimens must likewise be assigned in point of characters. No rattlesnakes of the species were found in the 16 days of field work in May, 1939, on Clark Mountain, where the race *stephensi* might be expected to occur.

Family TESTUDINIDAE

Gopherus agassizii (Cooper)

Desert Tortoise

N side Clark Mt., 7,400 ft., (old carapace seen); 7 mi. N Cima, January 12*; 2 mi. NNE Cima, May 13-14; 5 mi. SW Ivanpah, June 15*; 2½ mi. SW Kelso, June 19-21*; Colton Well, June 7. Total specimens, 5.

We found this species in a wide variety of situations. Adult tortoises, free from competition with related species, practically invulnerable to attacks by predators, and able to endure long periods without drinking water, roam widely over the area and apparently penetrate all available habitats. Most of the individuals found, including all the young ones, were in the low, hot, sandy areas, as at 2,100 feet altitude in the vicinity of Kelso, where four tortoises were found in a radius of 100 yards. Larger tortoises were seen also on the alluvial fans and in rocky canyons up to 4,700 feet. A bleached and broken carapace, gnawed at the edges by rodents, was found at the base of a cliff in the small Transition-zone patch of white firs, at 7,400 feet on the north side of Clark Mountain.

Our only winter record of the species was the finding of three large tortoises on January 12, 1938, in a mine tunnel seven miles north of Cima. The entrance was on a steep rocky slope supporting a scattered growth of yucca and cactus. The tunnel extended horizontally directly into the hillside about 60 feet, then sharply to the right about an equal distance. The tortoises were on the floor of the tunnel at its inner end, where it was completely dark and noticeably warmer than in the outside air. They were sluggish but not dormant. The largest of the three had a carapace 256 mm. long and 195 mm. wide.

Burrowing activities were observed near Cima and near Kelso. At the former locality two adult tortoises were seen on the evening of May 13, 1938, and again on the following morning. The smaller of the two was nearly out of sight in a hole, scarcely larger than the tortoise itself, which was dug almost horizontally into the side of a low hummock of earth (fig. 30). The larger individual was in the open, almost touching the other.

A tortoise released in the hot midday sun near Kelso on June 21, 1939, searched about until it found an old badger hole, into which it dug for about three feet before stopping. Released at another point, it found a ground squirrel burrow about three inches in diameter beneath a creosote bush and enlarged this hole until it had shaded itself completely from the sun. It seemed to dig entirely with the fore feet, using the hind feet to push the body forward. Remarkably little loose dirt appeared behind the tortoise. It made frequent "squirming" movements, by which it may have used the carapace to press aside and compact the loose, sandy soil in which it was burrowing.

In late June, tortoises were found abroad only in the relatively cool morning hours. Individuals placed in the sun at midday, when the temperature was

120° F., showed great distress, frothing at the mouth, chewing sand, and making frantic efforts to get into the shade. One placed on its back in the sun attempted to turn itself over by vigorously beating upward and inward with both feet on its left side. The momentum thus set up tilted the tortoise slightly toward the right; meanwhile, with the right fore foot and the snout it attempted to reach the ground. After brief periods of activity it would suddenly stop, draw its head and legs inside the shell, emit a hissing sound, and rest. Given ample time, a tortoise on its back on any but a smooth substrate would

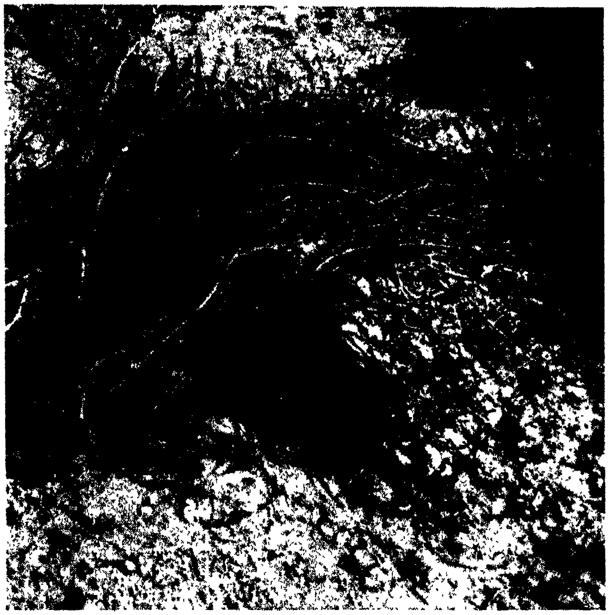


FIG. 30. Burrow of desert tortoise 2 miles north-northeast of Cima. Photograph taken May 14, 1938.

probably be able to right itself by these tactics, but this individual seemed likely to succumb to the heat, so it was helped over, after which it "hurried" into the shade of the tent.

When walking slowly, this tortoise dragged its plastron on the ground; at a faster walk it was lifted clear. The feet were put down and lifted without dragging, leaving distinct imprints of the foot scales in the sand. The succession of footfalls at slow speed was: left front, right rear, right front, left rear, left front, and so on. In walking more rapidly a fore foot and the hind foot on the opposite side were lifted almost simultaneously.

This same tortoise was returned, after about fifty hours without food, to the place it was first found. It began to crop the stems of a dry grass (*Oryzopsis hymenoides*). Its feces, which were dark brownish green in color and about 45 mm. long and 20 mm. in diameter, were made up principally of undigested stems of this or a similar grass. A large tortoise watched near Colton Well on June 7, 1938, ate stems of a cactus (*Opuntia ramosissima*) and berries of an unidentified green shrub.

BIRDS

Family ANATIDAE

Mergus serrator Linnaeus

Red-breasted Merganser

Hollister (1908:457) records "the sun-dried remains of a full plumaged male found [in early June, 1905] on the desert near the center of Ivanpah Valley. The bird probably perished from want of water."

Family CATHARTIDAE

Cathartes aura teter Friedmann

Turkey Vulture

8 mi. W Clark Mt., May 28; N side Clark Mt., May 25-29; Pachalka Spring, May 31; Valley Wells, June 1; Mountain Pass, Oct. 4; 2 mi. NNE Cima, May 12-19; Barnwell, May 30; Cedar Canyon, May 21-31*; 2½ mi. SW Kelso, June 19-22; Snake Spring, June 23-24. Hollister (1908:458) saw turkey vultures daily in Ivanpah Valley in early June, 1905. They gathered together from the surrounding deserts in the evening to roost on the high, rocky points on New York Mountain.

Turkey vultures were seen by us almost daily in May and June, soaring singly or in small groups over all types of terrain. They were not seen in midwinter. There was no altitudinal or zonal restriction evident in their foraging range; vultures circled both over our camp at 2,100 feet altitude in the sand dunes near Kelso and around the rugged cliffs at 6,500 feet north of Cedar Canyon.

The carcass of a recently killed horse on the floor of Cedar Canyon attracted at one time as many as six vultures which circled overhead, some high and some low; but, probably because our camp was within sight, they did not come to the ground. Shortly before sunset on May 26, and again on May 27, the vultures spiralled upward, without any wing flapping, in the updrafts over the north wall of the canyon and soared away northward in a straggling group.

A female vulture was accidentally caught in a steel trap, baited with the skinned body of a badger, set among bushes in the wash at Cedar Canyon on May 27. On the north side of Clark Mountain two vultures were seen perched on rocky ledges near a dead ground squirrel.

Several vultures were perched, apparently "loafing," on the fence surrounding a cattle corral in the Joshua tree area between Valley Wells and Kessler Spring on May 18, 1938. They were often seen in the vicinity of the open water-storage tanks and livestock watering troughs scattered through the yucca belt. At Barnwell, on May 30, 1938, two vultures were perched on the rim of a concrete trough and drinking, repeatedly dipping their bills into the water, but not raising their heads above a normal position.

It was a common experience, when we had set up our camp in a new locality, to have one or two vultures inspect it within the first twenty-four hours, wheeling a few times low overhead and peering down. On our first morning at Cedar Canyon a vulture perched a few minutes and watched us from the top of a rock bluff about 200 yards away.

Family Accipitriidae

Accipiter cooperii (Bonaparte)

Cooper Hawk

Pachalka Spring, Oct. 2; hills north of Cedar Canyon, May 25; 5 mi. NE Granite Well, Jan. 2 (1 specimen).

Cooper hawks were evidently resident, but not abundant, in the piñon woodland. One was perched in a dead piñon in a sagebrush covered flat, at about 5,400 feet altitude, in the hills north of Cedar Canyon on May 25, 1938. A male in the streaked juvenal plumage was taken at 5,400 feet altitude, 5 miles northeast of Granite Well on January 2, 1938. It was near a dense clump of oaks (*Quercus chrysolepis*) at the base of a piñon-covered hill.

Buteo jamaicensis calurus Cassin

Red-tailed Hawk

N side Clark Mt., 5,400 ft., May 26; Mescal Cave, May 18, 30; Nipton, Jan. 10; 3 mi. N Cima, Jan. 6-10*; 2 mi. NNE Cima, May 14-15*; Cedar Canyon, May 20-28*; Jan. 7, 5 mi. NE Granite Well, Dec. 28–Jan. 5; 6 mi. S Granite Well, Dec. 19-24; Mitchell's, Dec. 26; 2½ mi. SW Kelso, June 19-20. Total specimens, 4.

Fig. 31. Rock pinnacle at mouth of Cedar Canyon. Red-tailed hawks, white-throated swifts, and canyon wrens nested here. California myotis, rock squirrels, and wood rats used rocks for retreats. Photograph taken May 22, 1938.

Redtails were seen more frequently than were any other hawks in the area. They seemed equally abundant in winter and summer. Nests were found only at elevations between 4,000 and 5,000 feet, near the lower edge of the piñon belt, but foraging individuals were seen, even in June, at elevations as low as 2,100 feet. Soaring redtails were noted, singly, in pairs, and in threes, over all kinds of habitats. Perching individuals were seen on the ground among creosote bushes, in Joshua trees, in piñons, in junipers, on rocky pinnacles and cliffs, and on the poles of power lines.

Of three red-tailed hawk nests that were seen in 1938, two were on cliffs and the other was in a piñon. Near the lower end of Cedar Canyon, a pair had built a stick nest on a ledge on the nearly vertical west face of a conspicuous rock pinnacle (fig. 31). Three downy young were in the nest when it was visited on May 22 (fig. 32). Both parents were present, and the female dived repeatedly at the observer, sometimes coming within four feet of him, then rising nearly vertically and screaming. Another cliff-side nest was seen near Mescal Cave on May 18 and again on May 30. On the latter date the downy heads of two young hawks were peering over the edge. This nest was on an inaccessible ledge on the east-facing cliff that formed the wall of a canyon, about 250 feet

Fig. 32. Nest and three young of red-tailed hawk on rock pinnacle (see fig. 31) at mouth of Cedar Canyon. Photograph taken May 22, 1938.

above the canyon bottom. During most of the morning the young birds were exposed to the full force of the sun. Another pair of hawks had a nest in a large piñon high on a hillside overlooking the narrowest part of Cedar Canyon.

The nests may have been restricted to higher elevations because suitable trees and cliffs were few or lacking in the valley bottoms, or perhaps because the young hawks could not withstand the more intense heat to which they would be exposed at low altitudes for a considerable part of each day.

An immature male, collected on January 6, was in full juvenal plumage. An immature female was taken on May 24, at which time the molt to adult plumage had begun; the innermost pair of juvenal rectrices had been replaced by adult feathers that were about half grown. A male taken on May 15 and a female taken on January 12 were in the adult plumage of the light phase of *calurus*.

Buteo swainsoni Bonaparte

Swainson Hawk

A Swainson hawk nest was found on May 14, 1938, two miles north-northeast of Cima. The nest (fig. 33), which was approximately 3 feet in diameter

FIG. 33. Nest of Swainson hawk in Joshua tree 2 miles north-northeast of Cima. Photograph taken May 16, 1938.

and 3 feet high, was built about 15 feet from the ground in a crotch of an isolated Joshua tree. It was lined with fibers of Joshua tree bark. Two eggs were being incubated by a parent hawk. We saw only the one parent near the nest, and it was seen daily until we left the vicinity on May 19. It was wary, leaving the nest and flying away over the tree tops, sometimes silently, sometimes screaming loudly, whenever one of us approached. On one occasion it perched in the top of a Joshua tree, apparently undisturbed by the attacks of a pair of western kingbirds and a pair of shrikes. The nest was revisited on May 24, when it was found to have been abandoned.

Parabuteo unicinctus (Temminck)
Harris Hawk

A hawk seen by Marshall 6 miles south of Granite Well on December 22, 1937, is thought to have been of this species. As seen in flight, its body and wings were dark, almost black, above and below; its tail was black, with a white tip and a white base. It was circling over creosote bushes and yuccas in company with two red-tailed hawks, in comparison with which the Harris hawk seemed similar in size, but narrower winged and faster in flight. It dived at one of the redtails and engaged it in aërial maneuvers, in which the Harris hawk seemed definitely superior.

Aquila chrysaëtos canadensis (Linnaeus)
Golden Eagle

SE side Clark Mt., 6,300 ft., May 17; Cedar Canyon, May 21, 27; 5 mi. NE Granite Well, Jan. 5; Colton Well, June 7; 3 mi. NE Kelso, Jan. 3; Snake Spring, June 24.

Golden eagles were seen frequently, in winter and in summer, alone or in pairs, flying over the mountains and the broad alluvial fans. The many cliffs forming the higher parts of the Providence Mountains proper appeared eminently suitable as nesting sites for this species. An eagle perched a few minutes on May 17, 1939, on a rocky ledge on the south side of Clark Mountain. From the quantity of white excrement on the ledge, this was judged to be a regular perching spot; there was no nest material in sight.

In the winter trappers frequently catch eagles by accident in steel traps set for carnivores and baited with dead jackrabbits or burro meat. Two trappers told us they always released the eagles; one claimed they helped keep down the numbers of rodents that frequently sprung the traps. A kit fox (*Vulpes macrotis*) caught on December 26, 1937, by a member of our party in a steel trap on the creosote bush flat about two miles southwest of Colton Well was killed in the trap by an eagle. The entire fox was eaten, except the foot that was in the trap, part of the vertebral column, and one mandible. There were numerous eagle tracks mixed with those of the fox in the sand surrounding the trap.

Falco mexicanus Schlegel
Prairie Falcon

N side Clark Mt., 7,400 ft., May 20; SE side Clark Mt., 6,300 ft., May 17-20; Cedar Canyon, May 21-30; 2½ mi. SW Kelso, June 18. Stephens (1903:78) saw a prairie falcon in the Providence Mountains in 1902.

Prairie falcons were seen infrequently, and only during the summer field work. Most of the falcons were in the vicinity of cliffs, but there was no apparent altitudinal restriction; one was at 2,100 feet near Kelso, another at 7,400 feet near the summit of Clark Mountain.

In 1938, a prairie falcon was seen on several different occasions near cliffs at the head of Cedar Canyon (fig. 14). A "whitewashed" ledge may have been a regular perching site, but no nest site was apparent. In Cedar Canyon on

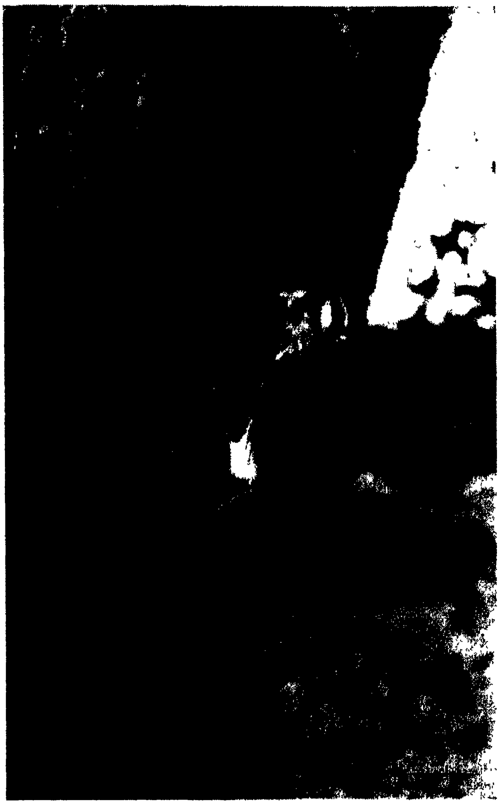


FIG. 34. Female sparrow hawk at opened nest hole in Joshua tree 5 miles southeast of Cima. Photograph taken May 20, 1938.

May 29, a falcon was chasing one of a pair of Cassin kingbirds, while the other kingbird in turn pursued the falcon. The chase did not last long, and the falcon flew away low over the bushes down the wash.

On May 20, 1939, a prairie falcon dashed out from a cliff at 7,400 feet altitude on the north side of Clark Mountain and struck at, but missed, one of two house finches that flew by.

Falco sparverius sparverius Linnaeus

Sparrow Hawk

SE side Clark Mt., May 19; Ivanpah Lake, March 29; 3 mi. N Cima, Jan. 10-12*; 2 mi. NNE Cima, May 12-16; Cima, May 12; Purdy, April 26; Lanfair Valley, Oct. 6; 5 mi. SE Cima,

May 19-23*, Dec. 28*; 2 mi. ESE Cedar Canyon, Oct. 6; between Cima and Kelso, Jan. 3; 3 mi. S Granite Well, Dec. 21; 6 mi. S Granite Well, Dec. 22; pass between Granite Mts. and Providence Mts., Oct. 7. Total specimens, 5. Seen in 1902 in the Providence Mountains by Stephens (1903:78).

Most of our sparrow hawk records are from the Joshua tree belt, at elevations between 4,000 and 5,000 feet. The species is resident in the area. Its local distribution is apparently conditioned chiefly by the occurrence of the Joshua trees, which provide perching and nesting sites. Sparrow hawks were only rarely seen among the piñons. On only two occasions were they found anywhere below the growth of yuccas: one was noted in flight over *Atriplex* along

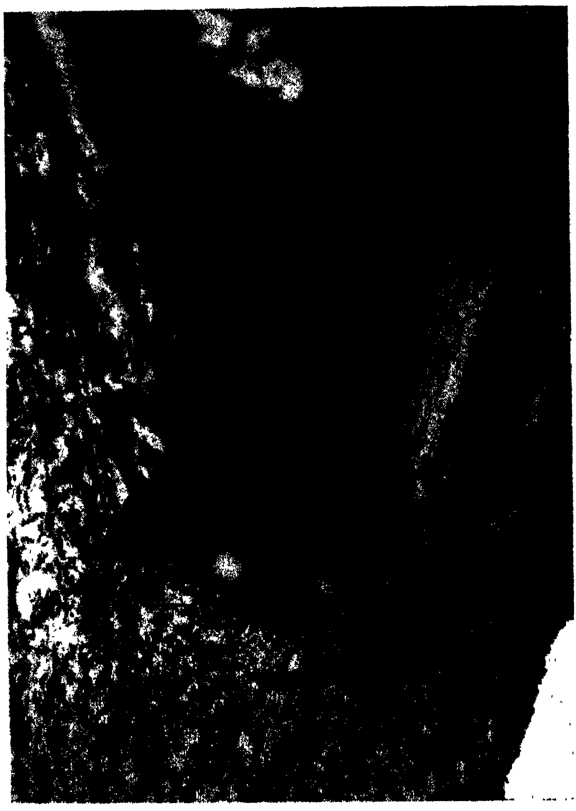


FIG. 35. Opened nest cavity of sparrow hawk (see fig. 34), showing four eggs of hawk and three of a flicker. Photograph taken May 20, 1938.

the border of the Ivanpah Lake bed on March 29, 1917, and one was perched on a telegraph pole beside the railroad tracks between Cima and Kelso on January 3, 1938.

A nest containing four eggs was pointed out to us on May 19, 1938, by Mr. A. H. Thomas on his ranch among the Joshua trees at 4,300 feet altitude, 5 miles southeast of Cima. The nesthole was a cavity, 55 inches from the ground, in a dead Joshua tree stub. It had evidently been made by a flicker, which had begun nesting there and was driven out by the sparrow hawk. Three addled

eggs of a flicker were still in the nest. A female sparrow hawk was incubating the eggs, but no male was seen in the vicinity of the nest. The female returned to the nest and settled down on the eggs even after one side of the cavity had been chopped out to expose the eggs for photographing. Before entering the nest the sparrow hawk clung woodpecker-like to the side of the trunk, with its tail spread and braced against the rough bark (figs. 34 and 35).

The stomach of a male sparrow hawk collected among Joshua trees 3 miles north of Cima on January 11, 1938, contained the remains of insects and a large pocket mouse (probably *Perognathus formosus*).

Family PHASIANIDAE

Lophortyx gambelii gambelii Gambel
Gambel Quail

8 mi. W Clark Mt., May 28*; 3 mi. N Cima, Jan. 9*, May 14; 1 mi. E Cima, May 14*; 2 mi. E Cima, May 13; 1 mi. N Barnwell, May 30; Cedar Canyon, Jan. 8, May 19–June 1; Rock Spring, May 27, 30; 2 mi. ESE Rock Spring, June 5; 5 mi. NE Granite Well, Dec. 31*; 3 mi. S Granite Well, Dec. 21; 6 mi. S Granite Well, Dec. 18-24*; Colton Well, June 7, Oct. 5; Mitchell's, Dec. 24, June 8-10; Snake Spring, June 25; pass between Granite Mts. and Providence Mts., Dec. 11. Total specimens, 14. "Two broods of young were seen at the foot of the Providence Mountains the latter part of May [1902]" by Stephens (1903:77).

In the rough, rocky terrain along the bases of the mountains, just below the piñon belt, Gambel quail were numerous and conspicuous in both summer and winter. The lowest record, altitudinally, is 3,200 feet (Colton Well); the highest is 5,400 feet (5 miles northeast of Granite Well). All the quail seen were near washes or boulder-strewn slopes. They were not found on the alluvial fans in the creosote bush or Joshua tree belts except along the borders of washes or the bases of rocky hills, nor were they found in the piñons. Large numbers of quail congregated around some of the springs and drank there regularly. Whether a supply of drinking water is necessary for this species at all seasons is uncertain. Quail were seen at such places as Colton Well and 8 miles west of Clark Mountain, at least two miles from the nearest surface water known to us; but possibly there were other small pools or springs in the vicinity.

Nesting was in progress in May, when we began our summer field work in 1938. Males were calling loudly near Cima on May 13, near Rock Spring on May 27, and near Barnwell on May 30. On June 5 a brood of very small quail was found two miles east-southeast of Rock Spring. Flocks of young, old enough to fly, were near Colton Well on June 7 and near Mitchell's on June 8.

In an hour's walk in the vicinity of Snake Spring, two sets of eggs and 13 flocks of quail, totaling an estimated 500 individuals, were found on June 25, 1940. Most of these quail were young, ranging from recently hatched to almost the size of adults. The nests were on fine gravel at the side of a wash and were almost completely hidden by grass and brush; there were 11 eggs in one, 14 in the other. These quail shared their water supply and foraging grounds with several families of introduced chuckar partridges.

In December, 1937, 50 quail were counted in one flock, and other flocks, some larger and some smaller, were seen 6 miles south of Granite Well. One

observer estimated that there were approximately 500 quail along a wash that followed the base of a rocky hill for about a mile. One flock, in which males outnumbered females two to one, was seen daily at almost the same place.

At Mitchell's, Gambel quail were being raised in pens, partly at least to be liberated in the vicinity. Several flocks of wild quail were about the place at the time. Incubating and brooding were carried on successfully by bantam hens.

At Colton Well a watering station had been constructed by the Division of Fish and Game in 1942. On October 5, 1945, as many as 50 quail were seen there. Chuckar partridges were reported introduced in the vicinity but were said not to be doing well. Introduction of Mountain Quail also was reported.

Family CHARADRIIDAE
Charadrius vociferus vociferus Linnaeus
Killdeer

This species was noted only in the fall, once at Mitchell's on October 5, and once at Colton Well, October 6.

Family LARIDAE
Larus delawarensis Ord
Ring-billed Gull

Hollister (1908:457) records having examined the remains of a ring-billed gull that had been shot as it was circling over the water tank at Ivanpah station "a few weeks previous" to his visit of early June, 1905.

Family COLUMBIDAE
Zenaidura macroura marginella (Woodhouse)
Mourning Dove

N side Clark Mt., May 24-26; Pachalka Spring, May 28, 31, Oct. 2; S and SE sides Clark Mt., May 20-21*; Mescal Spring, May 23, 29-30; Mescal Cave, May 30; 3 mi. N Cima, May 12, 14; 2 mi. NNE Cima, May 14-19*; 5 mi. SE Cima, May 20; Cedar Canyon, May 20–June 2; Government Holes, May 27; Rock Spring, May 27, 30; 2 mi. ESE Rock Spring, June 4-5; Kelso, June 21; 2½ mi. SW Kelso, June 18-23*; Snake Spring, June 24. Total specimens, 3. Hollister (1908:458) recorded mourning doves as being "fairly common in Ivanpah Valley and on New York Mountain" in early June, 1905.

Mourning doves occurred abundantly at elevations up to 5,400 feet in the summer. We saw none in the winter, although some may have been present in the area at low altitudes. A single bird was seen on October 2 at Pachalka Spring, 4,800 feet.

At Mescal Spring on the evening of May 29, 1939, and on the following day, doves poured in to drink at an open trough in numbers described by one observer as "hundreds" and by another as "thousands," coming and going continually from early morning until sunset. Large numbers were likewise seen at Pachalka Spring, Rock Spring, Government Holes, and Snake Spring, and at least a few individuals were to be seen wherever water was available for drinking. The greatest concentrations were observed at morning and evening, with a lull during midday.

Along a wash 2½ miles southwest of Kelso, between June 18 and 23, 1940, mourning doves spent the hottest midday periods perched on shaded branches or on the ground under desert willow trees. The nearest water was at the Kelso sewer outlet, two miles away, and doves were seen drinking there and flying in that direction. Young doves, able to fly but not fully grown, were on the ground beneath the desert willows. Strangely enough, we found no nests of this abundantly represented species.

Family Cuculidae
Geococcyx californianus (Lesson)
Road-runner

3 mi. N Cima, Jan. 11; Cedar Canyon, June 1; 1½ mi. SW Rock Spring, Oct. 6; Mitchell's, June 8, 10*; Snake Spring, June 24, 26; 8½ mi. NW Essex, Dec. 17. Hollister (1908:458) saw a road-runner in Ivanpah Valley near the base of New York Mountain in early June, 1905.

We found road-runners to be widely distributed but not abundant in summer and in winter, below the piñon belt. All but one of the six individuals that we saw alive crossed the road in front of our car on more or less level ground among low, scattered bushes. The exception was one seen running up the nearly vertical face of a huge granite boulder above Snake Spring.

One that was carrying something in its bill near Snake Spring on June 26, 1940, was pursued and shot. Its prey proved to be a young antelope ground squirrel, recently killed and grasped so tightly in the road-runner's bill that the vertebral column of the squirrel was broken.

At Mitchell's and at the Williams Ranch, three miles north of Cima, we were told that road-runners were very destructive to young quail, and for this reason they were killed by the local residents at every opportunity.

Family Strigidae
Otus flammeolus (Kaup)
Flammulated Owl

This species is represented by a single specimen, previously reported by Miller (1940:162), taken at 7,300 feet altitude on the north side of Clark Mountain, at 9 a. m. on May 20, 1939. It was in a grove of firs in the isolated patch of Transition Zone. This owl was a female. Lack of a brood patch and presence of ova up to 4 mm. in diameter indicated that the bird was soon to lay.

Otus asio cineraceus (Ridgway)
Otus asio gilmani Swarth
Screech Owl

SE side Clark Mt., 6,300 ft., May 16-17*; 5 mi. SE Cima, May 19-23; Cedar Canyon, Jan. 6-7*; May 19-27*; 5 mi. NE Granite Well, Dec. 29; Snake Spring, June 23. Total specimens, 8. Stephens (1903:100) flushed a screech owl from a thick piñon tree growing in a narrow gulch at about 5,000 feet altitude in the Providence Mountains in 1902.

The familiar calls of screech owls were commonly heard in the piñon forests on evenings in May and June and to a less extent in December and January.

The owls were much less frequently seen than heard, so our series of specimens is unfortunately small. The species was restricted to the vicinity of trees that served as perching sites and that had hollows suitable for nesting. Piñons and Joshua trees met these requirements, whereas desert willows, for some reason, were not found to harbor screech owls. Thus the local range of screech owls included the higher Joshua tree and piñon belts, but not the extensive creosote bush-covered alluvial fans and valley bottoms. The altitudinal range indicated by our records is from 4,100 to 6,300 feet.

Two nests were found in 1938, one in a Joshua tree, the other in a piñon. The first was pointed out to us by Mr. A. H. Thomas on his ranch, five miles south-

FIG. 36. Nest site of screech owl in stub of Joshua tree 5 miles southeast of Cima. Photograph taken May 22, 1938.

east of Cima. It was in a hollow, evidently an old woodpecker hole, about five feet from the ground in a Joshua tree stub (fig. 36). When we first saw it, on May 19, an adult and four downy young with closed eyes were in the nest. The parent was still brooding the young on the following day, but on May 21, 22, and 23, the parent was gone in the daytime. By May 23, the young owls had opened their eyes, and feathers had begun to grow on their wings.

The second nest was examined on May 27 in the dense piñon forest on the first terrace above the north wall of Cedar Canyon. It was near ground level at the bottom of a cavity in the trunk of a large piñon. The entrance was about four feet above the nest, on the east side of the tree. The nest contained six young owls, three male and three female, nearly ready to fly. At dusk an adult female called in the distance, then flew to a nearby tree, where it was shot. Later, well after dark, another screech owl, presumably the male parent, called in the vicinity, but it did not approach the nest. When the young owls were removed from the cavity, they were obviously frightened but belligerent, snapping their beaks and emitting low, growling sounds.

On the south side of Clark Mountain on the evening of May 16, 1939, a screech owl was shot from a narrow ledge ten feet above the base of a nearly vertical cliff. There were a few piñons near. In its stomach was a centipede two inches long.

Subspecific identification of screech owls from the Providence Mountains area has proved difficult. Only three of the eight specimens are in adult plumage. These have been compared critically with other specimens from localities in adjacent parts of California, Nevada, and Arizona, representing the subspecies *inyoensis*, *cineraceus*, and *gilmani*. It is at once obvious that none of our specimens exhibits the large size and the extent of white on the face and legs characteristic of *inyoensis*. The specimen (no. 77346, ♂) from 6,300 feet altitude on the south side of Clark Mountain is assigned to the race *cineraceus* on the basis of its more sharply defined pattern of streaks and vermiculations and its wider dorsal streaks, as contrasted with *gilmani*. The adult specimens (no 72691, ♂, Jan. 6, and no 74452, ♀, May 27) from Cedar Canyon, 29 miles south of Clark Mountain, are large enough to be called *cineraceus*, but in color they are nearest *gilmani* and are referred to the latter race. The female especially has the "peculiar earthy cast" and restricted dark markings on the dorsum described by Swarth (1910:2) as characteristic of *gilmani*. The male has equally restricted dorsal markings, but the ground color on the back, though it can be matched in other specimens of *gilmani*, is as dark as the average of *cineraceus*.

Bubo virginianus pallescens Stone

Horned Owl

N side Clark Mt., May 26; 3 mi. N. Cima, Jan. 11; Cedar Canyon, May 20-29; 5 mi. NE Granite Well, Dec. 29–Jan. 5*; 3 mi. S Granite Well, Dec. 21*; 6 mi. S Granite Well, Dec. 23-24; Snake Spring, June 25; pass between Granite Mts. and Providence Mts., June 10. Total specimens, 2. Stephens (1903:78) states that in 1902 "Mr. Brandegee saw two [horned owls] in the Providence Mountains."

Although there are definite records of the presence of horned owls only at elevations above 3,800 feet, their common occurrence on the unforested alluvial fans, as well as in the piñon belt, makes it seem probable that they range widely over the entire area.

In the daytime they were seen in rocky canyons or on cliffs, where potholes were used for diurnal retreats and, it is assumed, for nesting. For example, in a narrow gorge locally known as "Hole in the Wall," 3 miles south of Granite Well, two horned owls were seen on December 21, 1937. A male that was collected there was flushed from a pothole 75 feet above the base of a 100-foot cliff. A partly digested cottontail rabbit (*Sylvilagus audubonii*) was in its stomach. Other horned owls were flushed from cliffs in the daytime at the head of Cedar Canyon on May 29, 1938, and on the north side of Clark Mountain on May 26, 1939.

Foraging horned owls were seen or heard hooting on several occasions at dusk or shortly thereafter. At six miles south of Granite Well on the evening of December 23, 1937, one hovered with rapid wing beats over the head of a

member of our party who was setting traps on open ground in cholla cactus, *Yucca mohavensis*, and creosote bush association. Later it was seen flying in circles, apparently hunting, about 50 feet above the desert floor.

On the evening of June 25, 1940, an adult horned owl and a young one were observed near Snake Spring. When they were first seen, at 6:30 it was yet daylight, and the parent was making periodical visits, apparently bringing food, to the young one. Several times the young owl moved to a different perch between visits of the adult, but persistently uttered a "location" call of two syllables. These owls were active until after dark (8 p.m.), when the young one ceased calling. The parent hooted only once in that time.

Speotyto cunicularia hypugaea (Bonaparte)
Burrowing Owl

Burrowing owls were found by us only in the low, sandy area near Kelso. One was found dead and flattened in the road northeast of Kelso, at 2,300 feet altitude, on January 3, 1938. On June 21, 1940, a group of at least eleven burrowing owls was seen at 2,100 feet, 1½ miles southwest of Kelso. This was probably a family of young. Seven different burrows in a small radius were being used. When disturbed, the owls scattered, flying laboriously, one or two at a time, 100 yards or more away, and alighted on the ground in open spaces at a distance from one another and bobbed up and down.

Asio wilsonianus (Lesson)
Long-eared Owl

Calls consisting of single notes repeated at long intervals, thought to be of this species, were heard on a piñon-covered hillside five miles northeast of Granite Well at 9 p. m., December 27, 1937. There is substantiating evidence of the presence of long-eared owls in the area in the form of the remains of a bird picked up in June, 1940, at Essex, just outside the southern boundary.

Family CAPRIMULGIDAE
Phalaenoptilus nuttallii nuttallii (Audubon)
Poor-will

N side Clark Mt., 5,000 ft., May 24-27*; Pachalka Spring, May 31*, Oct. 2; S side Clark Mt., 5,000 ft., May 22; Mescal Spring, May 29*; 3 mi. N Ivanpah, April 25; 2 mi. NNE Cima, May 12-14; Cedar Canyon, May 20-25*; 2 mi. ESE Rock Spring, June 4. Total specimens, 8.

Poor-wills were found in summer at most localities near the bases of the mountains, that is, at elevations between 4,100 and 5,400 feet. There is only one record from a lower elevation: a poor-will heard calling at night, April 25, 1920, at about 3,000 feet, three miles north of Ivanpah. Most frequently the poor-wills were on the ground in open spaces among trees or bushes. They were in the piñon belt and on boulder-strewn slopes at Cedar Canyon, on a *Purshia*-covered flat two miles east-southeast of Rock Spring, and among Joshua trees

on the north side of Clark Mountain. At Pachalka Spring one alighted on the top of a fence post.

It is noteworthy that poor-wills were not found far from water. About Mescal Spring and Pachalka Spring numbers of poor-wills became active and vocal at dusk. On the piñon-covered slopes near a small pool at Cedar Canyon about eight poor-wills were calling at once on the evening of May 21, 1938. The local distribution appeared to be conditioned by the presence of surface water, which was almost entirely restricted to elevations above 4,000 feet. Poor-wills were apparently absent from the gravelly alluvial fans that, except for the absence of water, seemed to offer ideal nesting and foraging sites.

The familiar call note was given most commonly in the evening; it was heard earliest (on one occasion) at about one-half hour before sunset and was sometimes continued until about 10 p.m. On several occasions it was heard at dawn. A poor-will at Cedar Canyon made "clicking" noises as it flew.

All our specimens were collected in the period between May 22 and June 1, in 1938 and 1939, and probably represent the breeding population. The series of eight is, on the average, intermediate between the subspecies *nuttallii* and *hueyi;* it has been referred to the former, though by only a narrow margin. Four specimens (nos. 74199, ♀, and 74200, ♂, Cedar Canyon, 5,000 ft.; 77348 ♂, and 77349, ♂, north side Clark Mt., 5,000 ft.) are clearly *nuttallii* on the basis of the more frosted appearance of the upperparts and the larger black areas on the scapulars; three (nos. 77350, ♂, Mescal Spring, 5,000 ft.; 77352, ♀, and 77353, ♀, Pachalka Spring, 4,800 ft.) are nearer, though not typical of, *hueyi*, in that the dorsal ground color is more brownish and the black areas on the scapulars are smaller; one (77351, ♂, Pachalka Spring, 4,800 ft.) has the head as in *nuttallii*, the back more as in *hueyi*.

Even in the narrow vertical range represented by our series there is an indication of possible zonal differentiation between *nuttallii* and *hueyi*, in that Cedar Canyon and the north side of Clark Mountain, whence came the most *nuttallii*-like specimens, are more typically Upper Sonoran than are Mescal Spring and Pachalka Spring, where specimens approaching *hueyi* were taken. It seems best to apply but one name to our series until more detailed information is at hand. The chance of the *nuttallii*-like individuals being late migrants of a more northern population is remote, because two of the males had enlarged testes.

Chordeiles acutipennis texensis Lawrence
Trilling Nighthawk

Several trilling nighthawks flew about our camp in a once cultivated, but long abandoned, clearing on the Joshua tree–*Purshia* plain two miles east-southeast of Rock Spring at dusk, June 4, 1938. They flew in erratic courses, barely skimming over the ground and bushes, then wheeling to one side or darting upward. Two males and a female collected at that time had slightly enlarged gonads. On the following evening there were no nighthawks in sight. A young nighthawk in juvenal plumage was found dead in a road in the town of Kelso on June 22, 1940.

Family Apodidae

Aëronautes saxatalis saxatalis (Woodhouse)
White-throated Swift

NW side Clark Mt., 7,300 ft., May 20-29*, Oct. 3; SE side Clark Mt., 6,300 ft., May 16-22*; Mescal Cave, May 30; 2 mi. NNE Cima, May 26; Cedar Canyon, May 21-29*; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 5. White-throated swifts were recorded by Stephens (1903:101) as being "rather common on the Providence Mountains" in 1902, and by Hollister (1908:459) as flying around the highest peaks on New York Mountain in June, 1905.

In the summer, white-throated swifts were noted wherever there were high, fissured cliffs. Neither swifts nor cliffs suitable for them were seen below 4,100 feet altitude. On a very windy afternoon, May 16, 1938, a white-throated swift flew low over the Joshua tree forest northeast of Cima, fully three miles from cliffs of any size; otherwise all that we saw were in the usual cliff habitat.

Approximately twenty swifts were flying about the pinnacle-like outcropping at the mouth of Cedar Canyon on May 21, 1938. Some disappeared into and emerged from a fissure just beneath a red-tailed hawk's nest (figs. 31 and 32). Swifts also had nesting crevices at 7,300 feet on the northwest side of Clark Mountain, overlooking the Transition Zone fir timber and at Mescal Cave, the head of Cedar Canyon, and the south side of Clark Mountain. Aerial copulation was observed at the last-named locality on May 22, and at the mouth of Cedar Canyon on May 21. Two immature female white-throated swifts were shot in a narrow, cliff-walled side canyon north of Cedar Canyon on May 29, 1938. Mr. Mitchell told us that he had often seen swifts about the high cliffs above his place.

Calypte costae (Bourcier)
Costa Hummingbird

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,100-5,400 ft., May 25*; Pachalka Spring, May 31; southeast side Clark Mt., 5,000-5,500 ft., May 21-22*; Mescal Spring, May 30*; Mescal Cave, May 18*, May 30; 2 mi. N Cima, May 17; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 20–June 3*; Colton Well, June 7*; 2½ mi. SW Kelso, June 19; Snake Spring, June 24; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 11. Costa hummingbirds were noted as "not common" in the Providence Mountains in 1902 by Stephens (1903:101). Hollister (1908:459) found them common "about the watered gulches" on New York Mountain in June, 1905, and collected a specimen there.

Costa hummingbirds were common in summer throughout the area at elevations up to 5,500 feet. Above that level, at least on Clark Mountain, they were replaced by broad-tailed hummingbirds. Wherever there were trees or yuccas, Costa hummingbirds were likely to be seen or, as happened more frequently, heard diving. They were more common in the yucca and piñon woodlands (fig. 7) and about the desert willows along washes than on the brush-covered slopes. We noted them nesting or perching on a variety of plants, including piñon, desert willow, Joshua tree, *Yucca mohavensis*, and cholla cactus. Individuals were seen foraging at blossoms of *Yucca*, *Pentstemon*, *Lotus*, and *Amsinckia*.

Several nests were found. One observed and photographed by Aldrich near

Kessler Spring on May 17, 1938, contained two eggs. It was 8 feet above the ground in a Joshua tree, built close to the base of a dead flower stalk and partly shaded by the green, spine-like leaves. The nest was made of fragments of Joshua tree petals and leaf fibers and several large feathers, all compactly bound together with spider webs. The female was reluctant to leave the nest, and, although repeatedly frightened away, she always returned within a few minutes, and eventually would allow a hand to approach within four inches before she would leave. The upper part of her bill was covered to the base with yellow pollen. When not on the nest she usually perched, scratching and preening, on the uppermost tips of a *Yucca baccata*. Another nest with two eggs,

FIG. 37. Female Costa hummingbird on nest on dead segment of cholla cactus at Cedar Canyon. Photograph taken May 26, 1938.

seen on the north side of Clark Mountain on May 25, 1939, was on the tip of a yucca branch, where it was fully exposed to sunlight throughout the day.

A nest found at Cedar Canyon on May 26, 1938, was on the steep, west-facing wall of a ravine. The rim was 32 inches above the sloping ground, on a horizontal, dead segment of a cholla cactus. The nest was partly shaded by green stems of the same plant five inches overhead. In it were one newly hatched young, pieces of broken egg shell, and one "black" egg. The female stayed on the nest most of the time, but, perhaps because of the heat, she appeared to be shading the nest rather than sitting closely on it (fig. 37). On the piñon-covered plateau north of Cedar Canyon on May 25, 1938, a nest containing one egg was on a piñon limb 1½ inches in diameter, shaded by another limb six inches above.

Courting behavior was noted on the north side of Clark Mountain on May 27, 1938. A female was preening on a low perch when a male appeared and

started a series of dives, each dive accompanied by a loud, whining sound of falling pitch. After the male had made about six dives, both birds flew away. An immature male taken on May 22, 1939, on the south side of Clark Mountain was extremely fat.

A female drank water from a small rocky pool at Cedar Canyon in midafternoon on June 3, 1940.

Calypte anna (Lesson)
Anna Hummingbird

A female Anna hummingbird taken on May 18, 1939, among piñons at 6,300 feet altitude on the southeast side of Clark Mountain provides the first substantiated record of this coastal species in the eastern part of the Mohave Desert (see van Rossem, 1945*a*:80). There is no evidence that this bird was breeding, and no males of the species, which are ordinarily easily detected, were seen.

Selasphorus platycercus platycercus (Swainson)
Broad-tailed Hummingbird

N side Clark Mt., 5,400-5,500 ft., May 24*; NW side Clark Mt., 7,300 ft., May 20; SE side Clark Mt., 6,300 ft., May 16-20*. Total specimens, 5.

This species was found only in the summer on Clark Mountain, at elevations above 5,500 feet. An account of its occurrence there, its activities and characters has been published by Miller (1940:162). For the most part, broad-tailed hummingbirds were restricted to thickets of *Garrya flavescens* in the bottoms of ravines in the piñon belt. A few were also seen in the Transition Zone fir forest on the northwest side of the mountain. Although no nests were seen, courting behavior and apparent gathering of nest material indicated that the species was breeding there.

Family Picidae

Colaptes cafer collaris Vigors
Red-shafted Flicker

Pachalka Spring, Oct. 2; Cedar Canyon, Jan. 1-8*; 5 mi. NE Granite Well, Dec. 20-Jan. 2*; Mitchell's, Dec. 24-26. Total specimens, 8.

In December and January red-shafted flickers were abundant as winter visitants in the piñon forests. The greatest numbers were seen between January 5 and 8 in the well-developed piñon woodland on the plateau above the north rim of Cedar Canyon, where groups of up to six were foraging on the ground and in the trees. On January 2, five flickers mixed in with a large flock of piñon jays on the juniper- and sagebrush-covered flat south of Cedar Canyon.

At Mitchell's a flicker roosted over night at the inner end of a horizontal mine tunnel. At dawn on December 26, 1937, it emerged in precipitate flight over the beds of members of our party who had slept near the mouth of the tunnel. On the same day flickers were heard calling in fog and rain among the piñons above Mitchell's.

Colaptes chrysoides mearnsi Ridgway
Gilded Flicker

N side Clark Mt., May 25; SE side Clark Mt., May 17-18; 3 mi. N Cima, Jan. 9-12 (1 specimen); 5 mi. SE Cima, May 20.

Although we collected no flickers of this or the preceding species in the summer, the evidence at hand indicates that gilded flickers are resident in the Joshua tree belt. A male gilded flicker was collected from a loose flock of about five individuals in the dense Joshua tree forest 3 miles north of Cima on January 11, 1938. A nest cavity excavated by a flicker in a Joshua tree stub 5 miles southeast of Cima had been taken over by a sparrow hawk on May 19, 1938. At that time the nest held three addled flicker eggs and four fresh sparrow hawk eggs (fig. 35). A flicker was heard calling near there on May 20, but on May 23 an intensive search for flickers in the vicinity was unsuccessful. In May, 1939, flickers were heard or seen at three different places among or near Joshua trees on Clark Mountain. All these birds were unusually wary. In the summer no flickers of either species were present in the piñon forests, where *C. cafer* was conspicuous in the winter, or in the white fir belt on Clark Mountain.

The one specimen (no. 72703) is a male in fresh plumage. The shafts and undersurfaces of the rectrices and remiges are red, rather than yellow, thus agreeing in color with the four specimens of *Colaptes chrysoides mearnsi*, now at hand, described by Grinnell (1914:136-138) from near Laguna Dam on the Colorado River. In no characters other than this reddish wing and tail color does the specimen approach *Colaptes cafer collaris*. In its small size (wing 152 mm., tail 98 mm., culmen 37 mm., weight 126 grams) and pattern of markings (narrow transverse dorsal bars and extensive brown pileum) it is definitely of the species *C. chrysoides* and shows no indication of hybridization with *C. cafer*.

Asyndesmus lewis (Gray)
Lewis Woodpecker

Lewis woodpeckers were noted as winter visitants at Cedar Canyon, January 6 to 8, 1938 (2 specimens). Several were seen flying about and perched in the tops of large piñons on the plateau north of the canyon.

Sphyrapicus thyroideus nataliae (Malherbe)
Williamson Sapsucker

Cedar Canyon, Jan. 5-8 (4 specimens).

Williamson sapsuckers, like the foregoing species, were present in winter in the piñons on the north side of Cedar Canyon, where they were seen foraging on the trunks. The specimens are of the small-billed interior subspecies, *nataliae* (Grinnell and Miller, 1944:237).

Dendrocopos villosus leucothorectis (Oberholser)
Hairy Woodpecker

Miller (1940:102) has recorded the taking of a pair of hairy woodpeckers belonging to this subspecies in the Transition Zone at 7,300 feet on the north-

west side of Clark Mountain on May 20, 1939. The birds were nesting in a hole in the dead top of a white fir. Probably this was the only pair of hairy woodpeckers nesting in the area at that time.

Dendrocopos scalaris cactophilus (Oberholser)
Ladder-backed Woodpecker

N side Clark Mt., 5,000 ft., May 25*; Pachalka Spring, Oct. 2; S side Clark Mt., 5,000-5,300 ft., May 20-22; Mescal Spring, May 30*; Nipton, Jan. 10; 3 mi. N. Cima, Jan. 8-12*; 2 mi. NNE Cima, May 16*; Purdy, April 26; Cedar Canyon, Jan. 5-7, May 20-June 3*; Rock Spring, May 30; 5 mi. NE Granite Well, Dec. 28-Jan. 3*; 3 mi. S Granite Well, Dec. 21; 6 mi. S Granite Well, Dec. 19-25*; Colton Well, June 7*; Mitchell's, Dec. 26*, June 9; Snake Spring, June 24*. Total specimens, 30.

As a resident species throughout the yucca belt, these woodpeckers outnumbered all the other kinds of woodpeckers together. At no one place were they abundant, but individuals, pairs, or, at least in winter, groups of three or four were distributed regularly wherever there were yuccas. Usually one to four individuals could be seen in the course of a morning's hunting in favorable territory. Both species of treelike yuccas, the Joshua tree and *Yucca mohavensis*, seemed to provide a suitable habitat. Ladder-backed woodpeckers were observed at elevations between 3,000 feet (near Nipton) and 5,500 feet (above Mitchell's). At the latter locality on December 26, 1937, individuals were actively foraging in piñons, and at five miles northeast of Granite Well on January 3 two were seen in a dead juniper. Near Cima one foraged on the basal, woody stems of a cholla cactus. On most occasions, however, they were among yuccas, where one would be seen flying from one yucca to another, alighting on the trunk and hitching upward or around, occasionally calling, then flying on to another yucca. Where we found them among the lower and more exposed *Yucca mohavensis* they were more wary than among the Joshua trees and piñons.

Pairs were seen both in winter and in summer. On April 26, 1920, two pairs were noisily drumming and calling among Joshua trees near Purdy. Two nest holes were found in dead Joshua tree limbs, one on the south side of Clark Mountain and the other at Cedar Canyon. The latter was evidently in use on May 24. Males with enlarged testes were collected on May 25, May 30, and June 3. There was a group of young, recently out of the nest, near Colton Well on June 7.

Family Tyrannidae

Tyrannus verticalis Say
Western Kingbird

8 mi. W Clark Mt., May 28*; Cima (and vicinity), May 13-19*; Purdy, April 26*; Cedar Canyon, May 20-June 3*; Government Holes, May 27; 2 mi. ESE Rock Spring, June 4*. Total specimens, 7.

Western kingbirds occurred in summer at elevations between 3,300 feet (west of Clark Mountain) and 5,100 feet (Government Holes) in places where trees (or telegraph poles, or the upright posts of a cattle corral) provided outstanding and more or less isolated observation sites. Joshua trees were fre-

quented most commonly, junipers to a lesser extent. This species was not associated, other than incidentally, with piñons. The greatest numbers were at lower elevations, as near Cima, where eleven were seen on the morning of May 13, 1938. In nearly every instance they were in pairs.

On April 26, 1920, two pairs near Purdy were apparently established for nesting in Joshua trees. A male collected there on that date had enlarged testes, as did others taken at Cedar Canyon on May 30, 1938, and west of Clark Mountain on May 28, 1939. A nest at the last-named locality was in an exposed situation twelve feet from the ground in a crotch of a Joshua tree.

Tyrannus vociferans vociferans Swainson
Cassin Kingbird

Cassin kingbirds were found only at Cedar Canyon, where, in 1938, there were at least three individuals. One pair frequented a piñon-clothed slope. A female was shot from the top of a large piñon on May 28; it contained ova up to 5 mm. in diameter. The testes of a male that was collected on May 31 were 9 mm. long. Stephens (1903:102) saw a Cassin kingbird at the base of the Providence Mountains in 1902.

Myiarchus cinerascens cinerascens (Lawrence)
Ash-throated Flycatcher

8 mi. W Clark Mt., May 26-28*; N side Clark Mt., 5,000 ft., May 24-25*; Pachalka Spring, June 1; S and SE sides Clark Mt., 5,000-5,800 ft., May 20-22*; Valley Wells, June 1; Mescal Cave, May 30; 3 mi. N Ivanpah, April 25; 2 mi. NNE Cima, May 13-16*; 2 mi. E Cima, May 13*; 5 mi. SW Ivanpah, May 15; 1 mi. N Barnwell, May 30; Purdy, April 26-27; Cedar Canyon, May 25–June 3*; Government Holes, May 27; 2 mi. ESE Rock Spring, June 5*; Colton Well, June 7*; Kelso, June 21; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 12. In June, 1905, Hollister (1908:459) saw several individuals and collected specimens on New York Mountain.

Ash-throated flycatchers occurred in the summer throughout the area from the lower part of the piñon belt downward. The lowest elevation at which we have record is 2,200 feet, at Kelso, and the highest is 5,800 feet, on the southeast side of Clark Mountain. These flycatchers, like the western kingbirds, frequented open country, but in general used lower perches and were found in a greater variety of situations. Individuals were noted perched on junipers, Joshua trees, *Yucca mohavensis*, sagebrush, and rocks. Wherever they occurred, ash-throated flycatchers were noisy, conspicuous, and not wary. Usually they were in pairs. At least twelve individuals were seen near Cima on one morning.

At two miles north-northeast of Cima on May 13, 1938, ash-throated flycatchers were perching on low bushes and making frequent forays to pick up insects off the bare ground; apparently walking insects there provided a more convenient source of food than did flying ones.

Pairs were present three miles north of Ivanpah on April 25, 1920. A nest being constructed at Cedar Canyon on May 21, 1938, was in an old woodpecker hole in a juniper stub; a flycatcher was bringing fur of some kind to the

site. At Valley Wells, on June 1, a pair was feeding young in a nest that was under the canvas covering of an old piece of machinery. Young were out of the nest at Colton Well on June 7.

Sayornis nigricans semiatra (Vigors)

Black Phoebe

A black phoebe, possibly a straggler, was seen in Joshua tree association at 5,400 feet altitude on the north side of Clark Mountain on May 24, 1939. No habitat suitable for permanent residence by this species is known to occur in the area.

Sayornis saya saya (Bonaparte)

Say Phoebe

N side Clark Mt., 5,000 ft., May 25*; Pachalka Spring, May 31; Mescal Spring, May 23-30*; 2 mi. NNE Cima, May 12-16*; Mitchell's, June 9*; Colton Well, June 7; Kelso, Jan. 3*, June 21; 2½ mi. SW Kelso, June 19-20; Flynn, June 21; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 7. Stephens (1903:102) saw Say phoebes in the Providence Mountains in 1902.

Say phoebes occurred in favorable situations throughout the area below the piñon belt. The necessity of nesting sites on a ledge protected from sun and wind is a limiting factor. Before men had constructed bridges, shacks, and mine tunnels and had extended the water supply, the breeding population of Say phoebes in the area must have been even smaller than it is now. At higher elevations, up to 5,000 feet, we found this species only in the summer; near Kelso, at 2,200 feet, it was present in both summer and winter.

Where the sewer outlet from the town of Kelso made a small green oasis in the sandy desert, two Say phoebes, male and female, were collected on January 3, 1938. One was foraging from a low bush, making short sallies into the air and alighting in Bermuda grass. The other was foraging in typical flycatcher fashion from a telegraph wire. On June 21, 1940, another pair was at the same place. Two more pairs were found along the railroad within five miles west of Kelso, one near a small wooden culvert, the other at the siding of Flynn, where a long, wooden trestle spanned a wash.

There was a nest containing four half-grown young and with two anxious parents in attendance in an abandoned shack among Joshua trees northeast of Cima on May 14, 1938. The nest, which was made for the most part of string, ravelings from cloth that had been used to line the rooms, and other "artificial" material, was on a box which had been nailed to the wall five feet from the floor. The parents flew in and out through the open door and windows and had numerous foraging perches on nearby Joshua trees. There was an open water tank about three-fourths of a mile away. It is inconceivable that Say phoebes could have nested in this vicinity without the modifications brought about by human activity.

At Mitchell's a pair of phoebes had nested each year recently on a rock ledge just inside the entrance to one of the limestone caves. An immature male weighing 20.0 grams was taken near there on June 9, 1938. A male and a fe-

male Say phoebe appeared shortly before dark at a water trough at Mescal Spring on May 30, 1939.

The racial identification of Say phoebes of this area may require revision when fresh-plumaged birds of known local origin are available for study.

Empidonax traillii brewsteri Oberholser

Traill Flycatcher

Habitats suitable for breeding of this willow-seeking species are exceedingly rare in the Providence Mountains area. Two individuals were seen early in the summer of 1938; neither was breeding, judging from the reduced size of the gonads. A male taken at Cedar Canyon on May 28 was in a canyon-bottom strip of desert willows (*Chilopsis*), which, of all the plants in that vicinity, most nearly resembled true willows. A female taken on June 9 was perched in a tiny, isolated clump of willows near a spring in the rocky canyon above Mitchell's.

Empidonax hammondii (Xantus)

Hammond Flycatcher

Five individuals of this species that were collected in mid-May (17-22) on the southeast side of Clark Mountain, 6,000-6,300 feet, were migrants. They were found in canyons near the boundary between the yucca and piñon belts.

Empidonax wrightii Baird

Wright Flycatcher

SE side Clark Mt., 6,300 ft., May 18-20*; Mescal Cave, May 18*; Cedar Canyon, May 25*. Total specimens, 6.

Like the foregoing species, Wright flycatchers were found only as late spring migrants. Six specimens were collected between May 18 and May 25, 1938, and between May 18 and May 20, 1939, at elevations from 5,000 to 6,400 feet. They were in the piñon belt or near its lower edge. One was shot in a piñon, another in a juniper. There is no indication in our scanty notes on Wright and Hammond flycatchers that the two species occupy different habitats in migration.

Empidonax difficilis difficilis Baird

Western Flycatcher

NW side Clark Mt., May 20*; Pachalka Spring, May 31*; Mescal Cave, May 30; Cedar Canyon, May 20–June 2*. Total specimens, 8.

Migrating western flycatchers were collected or observed between May 20 and June 2, 1938, and between May 20 and May 31, 1939. They were all in bushes, usually where these grew as green thickets in wash bottoms and ravines. The altitudinal range represented is from 4,800 feet (in catclaw in a ravine near Pachalka Spring) to 7,300 feet (in the bottom of a ravine in the Transition Zone on the northwest side of Clark Mountain). Testes and ova of the birds collected, where their condition was noted, were small, even as late as June 2, indicating that these birds were not yet ready to breed.

Contopus richardsonii richardsonii (Swainson)

Wood Pewee

N side Clark Mt., 7,400 ft., May 28; S and SE sides Clark Mt., 5,400-7,500 ft., May 17-18*; 5 mi. SW Ivanpah, May 15; Cedar Canyon, May 19-31*; Government Holes, May 27; Rock Spring, May 27. Total specimens, 8. Wood pewees were found by Stephens (1903:102) to be "rather common and apparently resident" in the Providence Mountains in 1902.

Spring migrants of this species were abundant at Cedar Canyon from May 19 to 31, 1938, and on Clark Mountain from May 17 to 28, 1939. They were seen in a variety of habitats, perching in or foraging from piñons, junipers, Joshua trees, *Yucca mohavensis*, and low bushes at elevations between 4,500 feet (southwest of Ivanpah) and 7,500 feet (near the summit of Clark Mountain). One was seen on May 28, 1939, in the fir forest on the northwest side of Clark Mountain. Males with testes 5 mm. long were taken on May 21 and May 31, but there is no good evidence that pewees were breeding within the area.

Nuttallornis borealis (Swainson)

Olive-sided Flycatcher

A migrating olive-sided flycatcher was seen (by Bryant) eight miles west of Clark Mountain on May 28, 1939.

Family ALAUDIDAE

Eremophila alpestris lamprochroma (Oberholser)
Eremophila alpestris ammophila (Oberholser)
Eremophila alpestris leucansiptila (Oberholser)

Horned Lark

8 mi. W Clark Mt., May 26 (1 *leucansiptila*); Murphy Well, Jan. 10 (2 *ammophila*, 6 *leucansiptila*); edge of Ivanpah Lake Bed, March 29; 3 mi. N Cima, Jan. 9 (1 *lamprochroma*); 2 mi. NNE Cima, May 13-19 (2 *leucansiptila*); Cima and vicinity, May 12-16 (7 *leucansiptila*), June 1, 18; head of Cedar Canyon, May 21-30 (6 *leucansiptila*); Government Holes, May 27; 2 mi. ESE Rock Spring, June 4-5 (5 *leucansiptila*); Kelso, June 21; 2½ mi. SW Kelso, June 19. Total specimens, 30. Horned larks were recorded by Hollister (1908:460, under "*Otocoris alpestris pallida*") as being in Ivanpah Valley in early June, 1905; a few were breeding, and a family of young was seen.

Horned larks occurred in favorable situations both in winter and in summer, but it is not certain that any of the birds were strictly resident. Part, if not all, of the winter-taken horned larks were migrants from farther north. In January, the greatest numbers were found at low elevations, as about the edges of Ivanpah Lake, whereas in summer most of the horned larks were found at higher elevations. The vertical range in summer extended from 2,100 feet, near Kelso, to 5,100 feet, at the head of Cedar Canyon. Near Cima horned larks were nesting in May and June in places where Joshua trees and bushes had been cleared away by human agency, leaving open ground with a sparse growth of grass and other annuals. A young bird in juvenal plumage and apparently recently out of the nest was taken there on May 14, 1938, and another young horned lark was seen at the Cima post office on June 18, 1940.

At the head of Cedar Canyon there was an open "pasture" of several acres, on which grew a thin crop of grass and filaree, heavily grazed by cattle. Special search was made there for horned larks on January 1, 1938, without success, but on the following May 21, and on succeeding days at least until May 30, horned larks were abundant, 20 being seen in one morning. They were scattered out as if nesting, although neither nests nor young were seen. Three males and three females taken on May 27 had enlarged gonads.

At two miles east-southeast of Rock Spring on June 4, 1938, male horned larks were singing from perches and on the wing and were chasing other horned larks, apparently defending territories, in an abandoned cleared area in the Joshua tree belt. A female that was collected had a complete egg in the oviduct and two other eggs less complete.

In winter, horned larks were less abundant than in summer. A male was found foraging in the trampled mud of a cattle corral three miles north of Cima on January 9, 1938. On the following day eight horned larks were collected from a flock at Murphy Well, in the dry bed of Ivanpah Lake. The larks were alighting on the thin ice that had formed during the night on the water in a storage tank and were attempting to drink from shallow pools on the surface of the ice.

The summer-taken (breeding) specimens of horned larks are here assigned to the race *leucansiptila*, with the qualification that on the average they are almost exactly intermediate between that race and *ammophila*, which occurs over the entire Mohave Desert west of the Providence Mountains.

Three subspecies are represented among the winter-taken specimens. In the series of five males and three females taken at Murphy Well, the females and three of the males are pallid as in *leucansiptila* and are referred to that race. They differ from typical examples of *leucansiptila* from 20 miles southwest of Pilot Knob in comparable plumage (January 23-28) in having a yellowish cast on the head and back, the pinkish dorsal color in the males being restricted to a narrow collar. An approach to this condition is found in a series taken February 16 and 17 at Harrisburg (6 miles south of Ehrenberg), Yuma County, Arizona. The remaining two males from Murphy Well are darker and resemble most closely specimens of *ammophila* from Inyo County, California. The male from three miles north of Cima is still darker and is referred to the race *lamprochroma*.

Family Hirundinidae

Tachycineta thalassina lepida Mearns

Violet-green Swallow

NW side Clark Mt., 7,300 ft., May 20; SE side Clark Mt., 6,300 ft., May 16-21*; Mescal Cave, May 30; Purdy, April 26; Snake Spring, June 24-25*. Total specimens, 4. Found by Stephens (1903:104) to be "rather common about the summits of Providence Mountains, probably residents" in 1902.

This was the only swallow found breeding in the Providence Mountains area. Individuals were seen most commonly in May and June about cliffs and in deep canyons in the higher, rockier parts of the mountains. At Purdy on

April 26, 1920, four violet-green swallows were seen flying northwestward low over the tops of yuccas, possibly in migration.

On Clark Mountain, in 1939, violet-green swallows were seen almost daily in late May. They flew in company with white-throated swifts about sheer cliffs, especially the more shaded east-facing ones, on the southeast side of the mountain. On windy days they foraged more in the deep canyons where the air was quieter. Piñons and junipers were used as perching posts from which the swallows sallied out after insects. On May 17 they became active and made a continuous chatter by 3:30 a.m., when it was still almost dark. A female killed on May 21 had a large egg, complete except for the shell, in its oviduct. They were also seen about cliffs, apparently nesting, on the northwest side of the mountain at 7,300 feet, above the white fir forest; others were foraging among Joshua trees and cholla cactus in the yucca belt near the base of the mountain.

Riparia riparia riparia (Linnaeus)
Bank Swallow

Two bank swallows, evidently migrants, were seen (by Aldrich) two miles north-northeast of Cima on the morning of May 19, 1938.

Hirundo rustica erythrogaster Boddaert
Barn Swallow

A barn swallow was seen (by Aldrich) flying close to the ground in the Joshua tree belt near our camp two miles north-northeast of Cima on May 16, 1938.

Petrochelidon albifrons (Rafinesque)
Cliff Swallow

A cliff swallow was seen (by Aldrich) as it flew along the base of the prominent rocky pinnacle at the mouth of Cedar Canyon on May 21, 1938. Apparently this bird was a migrant.

Family Corvidae

Aphelocoma coerulescens nevadae Pitelka
Scrub Jay

N side Clark Mt., 5,400 ft., May 24-28*; Pachalka Spring, Oct. 2*; S and SE sides Clark Mt., 5,000-7,000 ft., May 16-23*; 3 mi. N Cima, Jan. 12; Cedar Canyon, Jan. 6-8*, May 20–June 4*; Government Holes, May 27; 5 mi. NE Granite Well, Dec. 28–Jan. 5*; Mitchell's, June 9. Total specimens, 18. Scrub jays were found on rugged mountain sides in the Providence Mountains in 1902 by Stephens (1903:102) and among junipers and piñons on New York Mountain in June, 1905, by Hollister (1908:460).

Jays of this species occurred as year-round residents along the bases of the mountains. The habitat most commonly occupied consisted of brushy thickets in canyon bottoms and at the bases of rocky hills in the piñon belt. Foraging individuals and small groups ranged widely, being noted in association with piñons, junipers, desert willows, Joshua trees, tall sagebrush, and cholla cactus.

All our records are from altitudes between 4,500 feet (near Mitchell's) and 7,000 feet (on Clark Mountain).

At all seasons these jays were wary and difficult to approach. During the nesting season they were silent, but after the young were out of the nest, the foraging family groups were made conspicuous by their continual calling. Loose flocks of as many as eight jays foraged through the piñon forests and over juniper and sagebrush-covered flats in the winter. At 5 miles northeast of Granite Well on January 2, 1938, several scrub jays were calling excitedly from perches on the periphery of a wandering flock of about 400 piñon jays. To one observer it seemed that the scrub jays resented and were protesting the presence of the other species.

A nest found at 6,300 feet on the southeast side of Clark Mountain was 12 feet above the ground in fairly open branches on the east side of a piñon. The tree, which was partly overshadowed by a larger tree growing on the slope above it, was on the talus at the base of cliffs forming the south wall of a canyon. On May 18, 1939, the nest was about half finished, consisting of a scanty substructure and a loose cup of lining material. One of the jays, which was shot as it approached the nest, proved to be the male. It was carrying a thin rootlet in its bill. On May 23 the female had apparently found another mate, for a pair was seen visiting the tree frequently, and the nest appeared complete. This must have been an example of unusually late nesting, because in 1938 young jays were out of the nest and on the wing at Cedar Canyon by May 25.

Corvus corax sinuatus Wagler
Holarctic Raven

Purdy, April 26; Kelso, June 23; 2½ mi. SW Kelso, June 19-23; Snake Spring, June 24.

In our experience ravens were not common in the Providence Mountains area. We saw them only in the summertime, and only in the Lower Sonoran Zone. At about sunrise on June 19 and 20, and again on June 23, 1940, one or more ravens flew along the railroad track, croaking occasionally, near our camp southwest of Kelso. At about noon on June 23 a group of about five ravens was seen at the outskirts of the town of Kelso. On April 26, 1920, two ravens were seen in flight over Joshua trees at Purdy.

Gymnorhinus cyanocephalus Wied
Piñon Jay

Clark Mt., Oct. 3; 2 mi. SE Cima, Dec. 20*; Barnwell, April 25; Cedar Canyon, May 20-31*; 5 mi. NE Granite Well, Dec. 28–Jan. 2*. Total specimens, 5.

Piñon jays, in characteristic large flocks, were conspicuous and noisy in summer and winter in the vicinity of Cedar Canyon. They seemed to find conditions most suitable on the rolling piñon- and juniper-covered Mid Hills section between the New York Mountains and the Providence Mountains proper.

A flock estimated to include 400 piñon jays was foraging through junipers on a sagebrush flat and through piñons on an adjacent hillside five miles north-

east of Granite Well on January 2, 1938. The birds flew from tree to tree, calling frequently, and the flock drifted steadily along as a unit. When a shot was fired into its midst, the entire flock rose high in the air and flew away toward the north. In the winter these jays also foraged among the Joshua trees; for example, a large flock was seen on December 20, 1937, at the Death Valley Mine, two miles southeast of Cima.

When we arrived at Cedar Canyon in the latter part of May, 1938, both large and small flocks and a few apparently solitary individuals were to be seen. The flocks contained many young birds which followed the adults and begged for food.

Family PARIDAE

Parus gambeli inyoensis (Grinnell)

Mountain Chickadee

The three males recorded by Miller (1940:162) as taken in the white fir forest on the northwest side of Clark Mountain, 7,100-7,300 feet, are the only chickadees known from the Providence Mountains area. These birds, taken on May 20 and 24, 1939, were singing, had enlarged testes, and in general behaved like breeding birds. No females were apparent. We saw no trace of chickadees of any kind in the southern part of the area, either in summer or in winter.

Parus inornatus ridgwayi Richmond

Plain Titmouse

N side Clark Mt., May 24; SE side Clark Mt., 5,300-6,300 ft., May 16-21*; Cedar Canyon, Jan. 1-9*, May 20–June 4*; 5 mi. NE Granite Well, Dec. 27–Jan. 2*; Mitchell's, Dec. 25*; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 68. Stephens (1903:105) saw two titmice in the Providence Mountains in 1902. Hollister (1908:461) found them "fairly common among the junipers on New York Mountain" in early June, 1905, and collected a specimen (on June 9, according to Grinnell, 1923*a*:135).

At most localities where there were piñons or junipers, small numbers of titmice were present in winter and summer. They probably ranged throughout the piñon-juniper belt. The altitudinal range shown by our records is from 4,100 feet, in the pass between the Granite Mountains and the Providence Mountains, to at least 6,600 feet, on the north side of Clark Mountain. Titmice were found singly, in pairs, and in small family groups. In the winter they were frequently seen closely associated with small flocks of juncos and once with a red-breasted nuthatch. At Cedar Canyon, at both seasons, titmice were exceptionally abundant.

They foraged mostly on the trunks and branches of piñon and juniper trees. At times they were seen on the ground near the bases of trees and yuccas. They were unwary and exhibited a great deal of curiosity.

Titmice were carrying insect food, presumably for young in the nest, on the southeast side of Clark Mountain on May 18, 1939. A nest found on May 24 in the hollow stub of a half-dead piñon on the north side of the mountain contained young estimated to be six days old.

At Cedar Canyon a nest was found on May 29 in a cavity in the erect trunk of a dead, unbranched Joshua tree; probably, the cavity had been dug originally by a ladder-backed woodpecker. A parent was carrying food to the nest hole. The earliest date at which young were seen out of the nest was May 26, 1938, at Cedar Canyon. The young birds followed after the parents, which sought out and dug into ant lion pits on the ground beneath trees and also foraged at the bases of *Yucca baccata.*

Within the Providence Mountains area the contrast between the abundance of titmice at Cedar Canyon and their relative scarcity elsewhere was striking. The use of Joshua trees as nesting sites, as described above, might account for the large population at Cedar Canyon, where Joshua trees were freely intermingled with piñons and junipers, a combination that is seldom duplicated. Holes are commonly excavated in the soft "wood" of the Joshua trees by ladder-backed woodpeckers, and these holes are later available to other birds, such as titmice, for nesting. Suitable holes in the hard wood of piñons and junipers are scarce. Thus at Cedar Canyon the titmice found the rare and, to them, ideal combination of yuccas for nesting and piñons for foraging.

Auriparus flaviceps acaciarum Grinnell

Verdin

8 mi. W Clark Mt., May 25-28*; Cedar Canyon, Jan. 5*; 6 mi. S Granite Well, Dec. 19-24*; Colton Well, June 7-8*; 2½ mi. SW Kelso, June 20-21*. Total specimens, 9.

Verdins were present in summer and in winter, mostly as solitary individuals, in desert willows and catclaw and creosote bushes along washes in the Lower Sonoran Zone, at elevations up to 5,000 feet. One was shot from a *Yucca mohavensis* surrounded by creosote bushes. The local range was complementary to the ranges of bush-tits and titmice, but, because the habitat suitable for parids was limited and discontinuous below the piñon belt, the verdins were rare in comparison with the other two species. There was no apparent flocking tendency; even young birds in juvenal plumage were solitary. At Cedar Canyon on January 5, 1938, two verdins foraged in low bushes near juncos, spotted towhees, and white-crowned sparrows.

A recently evacuated nest seen at Colton Well on June 7, 1938, was 5½ feet above the ground in a creosote bush. It was made almost entirely of creosote bush twigs, with little attempt at lining. An adult male and three young verdins were seen at different places in the vicinity. Other young verdins were taken at 8 miles west of Clark Mountain on May 26, 1939, and at 2½ miles southwest of Kelso on June 20, 1940.

Psaltriparus minimus providentialis Arvey

Bush-tit

N side Clark Mt., 5,400 ft., May 28; NW side Clark Mt., 7,300 ft., May 20; SE side Clark Mt., 6,000-6,300 ft., May 16-19*; Mescal Cave, May 18*; 5 mi. SW Ivanpah, May 15; 2-3 mi. N Cedar Canyon, May 25*; Cedar Canyon, Jan. 5-8*, May 20–June 4*; Government Holes, May 27; 5 mi. NE Granite Well, Dec. 27–Jan. 5*; Mitchell's, Dec. 26, June 9; Snake

Spring, June 23. Total specimens, 78. Stephens (1903:105) saw a small flock of bush-tits in the Providence Mountains in 1902. Hollister (1908:461) saw several bands among junipers on New York Mountain in June, 1905.

Bush-tits were abundant residents, in winter and summer, throughout the piñon belt. Altitudinal extremes in our records are 4,100 feet (Snake Spring) and 7,300 feet (northwest side of Clark Mountain). Within these limits they occupied for the most part the areas of rougher terrain (slopes, ridges, talus, and canyon walls) almost always in the vicinity of piñons and junipers. They foraged principally in the outer, finer foliage of these trees and to a lesser extent in the branches of tall sagebrush and other shrubs that grew in patches interspersed with the conifers. On a few occasions they were seen in desert willows at Cedar Canyon. Their ability to forage in bushes as well as in trees gave the bush-tits a less restricted local distribution than that of the titmice, which had almost exactly the same general occurrence but foraged on the trunks and larger branches of conifers.

In the winter bush-tits were in large and small flocks, some estimated to contain 100 individuals. Occasionally one or two birds of other species, such as ruby-crowned kinglets and Bewick wrens, were included in the flocks. Bush-tits were most abundant at five miles northeast of Granite Well. There the flocks foraged through the piñons on a north-facing slope, in the brush thickets at the base of the hill, and among the junipers and sagebrush on the adjacent flats.

By May 15, 1938, and May 16, 1939, when our field parties first reached bush-tit territory, pairs and nesting groups were evenly distributed and apparently isolated from one another. A nest at 6,300 feet altitude on the southeast side of Clark Mountain was near the tip of a side limb in the crown of a 25-foot-high piñon, which grew on the basal talus of a north-facing cliff. On May 18, 1939, at least three adult birds were about the nest. When one of the adults entered the nest, young birds could be heard inside. An adult male that was shot proved to be sexually active. Later two adults flew to an adjacent tree, where they copulated. One of them that was collected soon afterward was a female with a brood patch; it was carrying a grub in its bill. At Cedar Canyon, a family group of young bush-tits was out of the nest and foraging with its parents on May 28, 1938, and thereafter such groups were frequently seen. Nesting was not altogether finished, however, for a female shot on June 3 from among a group of young had an egg almost completely formed in its oviduct.

The entrance hole of a nest from which a brood of young departed at Cedar Canyon on about June 1 is about half way up one side, its lower margin about 50 mm. above the floor of the cavity. The nest is composed of a miscellany of small leaves, twigs, seed capsules, grass stems, and piñon needles, all bound together with spider webs and fine plant fibers. The cavity is lined with large, soft feathers, some of which are scapulars of a screech owl.

The subspecific status of bush-tits from the Providence Mountains and adjacent areas has been discussed by Arvey (1941:74-75).

Family SITTIDAE

Sitta canadensis Linnaeus

Red-breasted Nuthatch

NW side Clark Mt., 7,300 ft., May 24*, May 29; Cedar Canyon, Jan. 5-8*; 5 mi. NE Granite Well, Dec. 28-30*. Total specimens, 6.

In the winter a few solitary red-breasted nuthatches were among the abundant bush-tits, flickers, juncos, and titmice in the piñon forests. They stayed close to the larger piñon and juniper trees.

On May 24, 1939, a red-breasted nuthatch was singing in the fir forest at 7,300 feet altitude on the northwest side of Clark Mountain. When collected, it proved to be a male with testes 5 mm. long. On the morning of May 29 another nuthatch was heard in the same vicinity. There is no further evidence of the presence of nuthatches in the area in summer.

Family TROGLODYTIDAE

Thryomanes bewickii eremophilus Oberholser

Bewick Wren

8 mi. W Clark Mt., May 26; N and NW sides Clark Mt., 5,400-7,400 ft., May 20-28*; Pachalka Spring, Oct. 2*; S and SE sides Clark Mt., 5,000 ft.-summit, May 17-22*; Mescal Spring, May 30*; 3 mi. N Cima, Jan. 10-13*; Cedar Canyon, Jan. 8*, May 20–June 3*; 5 mi. NE Granite Well, Dec. 30–Jan. 5*; 3 mi. S Granite Well, Dec. 21*; 6 mi. S Granite Well, Dec. 23-24*; Mitchell's, June 9, Dec. 25; Snake Spring, June 24; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 31.

Bewick wrens were commonly seen, as scattered individuals and pairs, both in summer and in winter. The species had a wide altitudinal and zonal range, which extended from the Lower Sonoran valley floor at 3,300 feet, 8 miles west of Clark Mountain, to about 7,900 feet, within a few yards of the summit of Clark Mountain, and into the fir forest on its northwest side. As far as our observations show, summer and winter ranges were the same. The chief environmental requisite for Bewick wrens appeared to be brush thickets of some kind, and even this loose designation must be extended to include clumps of *Yucca baccata*. On the alluvial fans suitable habitats were usually found only along washes. Higher in the mountains they were in canyon bottoms and in the thickets in talus about the bases of cliffs and rocky outcroppings. Bewick wrens were noted definitely in association with piñon, juniper, Joshua tree, *Yucca mohavensis*, *Yucca baccata*, creosote bush, sagebrush, desert willow, white fir, cactus, and unspecified shrubs. For singing posts, males used dead limbs of piñons and junipers, rocky prominences, small Joshua trees, and the flower stalks of *Yucca baccata*.

Fragments of song were heard in midwinter, as at 5 miles northeast of Granite Well on January 2, and at 3 miles north of Cima on January 10 and 11, 1938. Males were singing vigorously and nesting was evidently in progress when we resumed field work the following May. At Cedar Canyon on May 28 a Bewick wren chased a chipmunk down a yucca that had an old woodpecker

hole near the top. Young birds were out of the nest on the north side of Clark Mountain on May 24, 1939, and at Cedar Canyon on May 28, 1938.

Campylorhynchus brunneicapillus couesi Sharpe
Cactus Wren

8 mi. W Clark Mt., May 25*; N side Clark Mt., 5,000 ft., May 25; S side Clark Mt., 5,000 ft., May 21; vicinity of Barnwell, March 29, May 30; Purdy, April 26*; 3 mi. N Cima, Jan. 9-12*; 2 mi. NNE Cima, May 16-19*; Cima, May 16*; 5 mi. SE Cima, May 23; Cedar Canyon, Jan. 3-8*, May 20–June 1*; 6 mi. S Granite Well, Dec. 18-24*; Colton Well, June 7; Mitchell's, June 9-10*, Dec. 24-27; Snake Spring, June 24. Total specimens, 17. In 1902, Stephens (1903:105) shot a cactus wren at the base of the Providence Mountains.

Cactus wrens were resident throughout the yucca belt, with a vertical range from 3,200 feet (Colton Well) to 5,000 feet (on Clark Mountain). They were

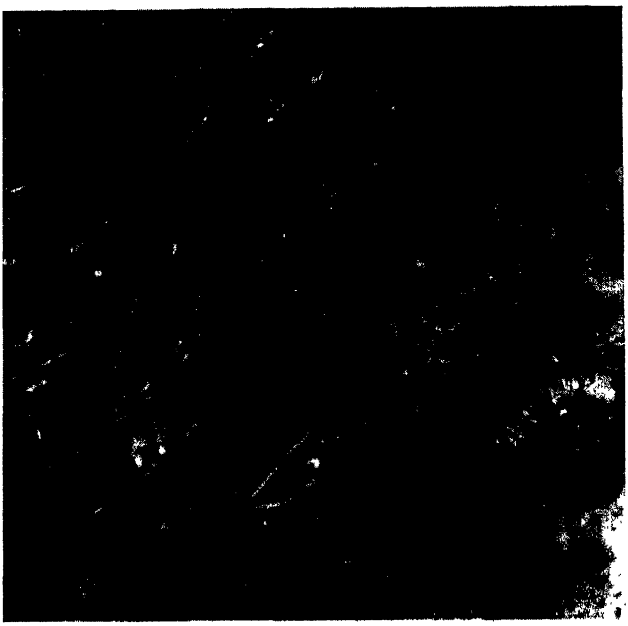


FIG. 38. Nest of cactus wren in cholla at mouth of Cedar Canyon. Photograph taken May 23, 1938.

most abundant in the rough terrain near the bases of the mountains, as at the mouth of Cedar Canyon. They were noted most frequently in cholla cactus, *Yucca mohavensis*, and Joshua trees, and less frequently in junipers and piñons.

In the winter, cactus wrens foraged together in loose flocks numbering up to ten individuals. In the summer only solitary individuals, pairs, or family groups of young were seen.

The bulky nests were conspicuous in many places. At Purdy on April 26, 1920, a nest two feet above ground in a cholla cactus contained four young wrens nearly ready to fly. Other young cactus wrens were out of the nest near Cima on May 19, 1938. At the mouth of Cedar Canyon on May 22, 1938, all but one of several nests examined proved to be "dummies." The occupied nest (fig. 38) was in a cholla cactus, 37 inches above the ground. It was 11

inches long, and at its largest diameter was 7½ inches wide and 6 inches deep. The entrance was 2 inches in diameter. The nest was made of dry grass and lined with fine grass, feathers, and fibers of Joshua tree leaves. It contained five eggs. On the same date there were at least four young wrens in a nest farther up Cedar Canyon.

Catherpes mexicanus conspersus Ridgway
Canyon Wren

NW side Clark Mt., 7,400 ft., May 28-29*; SE side Clark Mt., 6,300 ft., May 18-23*; Mescal Cave, May 18*, 30; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, Jan. 5*, May 21-23; 6 mi. S Granite Well, Dec. 24*; Mitchell's June 9*, Dec. 26; Snake Spring, June 23-24; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 9. In 1902 Stephens (1903:105) saw canyon wrens in the Providence Mountains, and in 1905 Hollister (1908: 461) found them to be common on New York Mountain.

In deep canyons and on shaded, north-facing cliffs and talus slopes, canyon wrens were heard, and occasionally seen, in summer and in winter. The lowest altitude represented in our records is 3,800 feet, six miles south of Granite Well; the highest is 7,400 feet, on the northwest side of Clark Mountain. The zonal range is thus from Lower Sonoran to Transition, but in the shaded recesses occupied by canyon wrens, conditions appear relatively uniform regardless of altitude. They were noted more often in the summer, perhaps because they sang more at that season. Individuals or pairs were widely spaced.

At Cedar Canyon on January 5, 1938, a canyon wren called repeatedly from a rocky slope, then flew into view, carrying a 2½ inch caterpillar in its bill. It disappeared for some time behind a large boulder, then, when disturbed, flew out of a crevice and stood bobbing up and down on a rock.

On May 21, 1938, young were present in a nest in the basal talus of a rock pinnacle at the mouth of Cedar Canyon. A parent was singing there regularly, and one wren flew down the slope carrying feces in its bill.

Salpinctes obsoletus obsoletus (Say)
Rock Wren

N side Clark Mt., 5,500-7,300 ft., May 24-29*; Pachalka Spring, May 31*; SE side Clark Mt., 6,300 ft., May 16-21*; Mescal Cave, May 30; Cedar Canyon, May 20–June 1*; 1½ mi. SW Rock Spring, Oct. 6; 5 mi. NE Granite Well, Dec. 29; 3 mi. S Granite Well, Dec. 21*; 6 mi. S Granite Well, Dec. 18-24*; Colton Well, June 7*, Oct. 5; Mitchell's, June 9*, Dec. 26-27; Snake Spring, June 23-24; 8½ mi. NW Essex, June 10. Total specimens, 19. Stephens (1903:105) heard rock wrens in 1902 in the Providence Mountains, and Hollister (1908:461) found them on New York Mountain in 1905.

Rock wrens were common and widely distributed residents in rocky places at all elevations from Colton Well, at 3,200 feet, to near the summit of Clark Mountain. They were noted in a variety of situations, all characterized by absence or fewness of trees, exposure to sunlight, and presence of large or small rocks. Their preference for sunny places was pronounced; in a canyon on the southeast side of Clark Mountain they were active and noisy on the sunny side on the evening of May 17, 1939. On the following morning the activity had shifted to the opposite side of the canyon, where the sunlight first struck.

In frequenting sunny rather than shaded places, rock wrens avoided competition with canyon wrens, and because of their less restricted habitat, the rock wrens were by far the more abundant of the two species. They were sometimes seen on bare ground, and when disturbed there they tended to run, rather than fly, to safety behind rocks. Large boulders or rock outcrops were the favorite perching places, but occasionally they stopped momentarily in piñons, junipers, yuccas, sagebrush, or cholla cactus.

An adult carrying food in its bill to a spot on cliffs at the head of Cedar Canyon on May 24, 1939, and another carrying feces near Mescal Cave on May 30 indicated that young were then in the nest. Young birds were recently out of the nest at Pachalka Spring on May 31 and at Colton Well on June 7.

Family Mimidae

Mimus polyglottos leucopterus (Vigors)

Mockingbird

N side Clark Mt., 5,000 ft., May 24-25; 8 mi. W Clark Mt., May 28*; S and SE sides Clark Mt., 5,400-5,700 ft., May 19-22*; Mescal Spring, May 23, May 29-30; 3 mi. N Ivanpah, April 25; 2 mi. NNE Cima, May 13-15*; Purdy, April 27; Cedar Canyon, May 20–June 3*; Government Holes, May 27; 2 mi. ESE Rock Spring, June 4; 5 mi. NE Granite Well, Dec. 31*; Snake Spring, June 24. Total specimens, 7. Stephens (1903:105) saw a mockingbird at the base of the Providence Mountains in 1902.

Mockingbirds were present sparingly in winter and abundantly in summer below the piñon belt. The greatest numbers were seen where Joshua trees or junipers were adjacent to open grass- or brush-covered areas (fig. 8). Altitudinally, the species ranged from 3,000 feet, in Ivanpah Valley, to 5,700 feet, on Clark Mountain. At the upper edge of this range it encountered piñons, but seemed to prefer the Joshua trees for perches and dense bushes for nesting. Where Joshua trees were not available, mockingbirds perched and sang on the tips of juniper branches.

Vigorous and prolonged singing was carried on by mockingbirds all during our spring and summer field work. In Cedar Canyon one sang day and night from a Joshua tree near our camp. On May 31, 1938, it was singing in the middle of the moonless night, at dawn, and again in the hot sunlight at 11 a. m.

A female taken on May 21, 1939, on the north side of Clark Mountain had an egg, that was ready to be laid, in the lower part of its oviduct. On May 24, 1938, a nest containing five eggs was found only about four feet from the ground in a thick bush in open brushland in Cedar Canyon. Both parents were present but very wary. A brood of young was out of the nest and flying with fair proficiency along a wash eight miles west of Clark Mountain on May 28, 1939.

Oreoscoptes montanus (Townsend)

Sage Thrasher

An adult female sage thrasher was taken three miles north of Cima on January 12, 1938. It had been foraging with a small group of Bell sparrows in a brushy clearing among Joshua trees, at 4,500 feet altitude. When disturbed, it flew to the top of a *Yucca mohavensis* at the edge of the clearing.

Toxostoma bendirei (Coues)
Bendire Thrasher

2 mi. NNE Cima, May 13-16*; 1 mi. N Cima, June 18; 2 mi. ESE Rock Spring, June 4-5*. Total specimens, 7.

Bendire thrashers were found at two places in the summer of 1938. In each instance they were on nearly level terrain among scattered Joshua trees. The species was apparently migratory, because none was found in January near Cima, where the birds were conspicuous in May.

On May 13, the first day in our camp two miles north-northeast of Cima, an adult male Bendire thrasher was seen first running on the ground, then

FIG. 39. Nest site of Bendire thrasher in *Opuntia ramosissima* 2 miles north-northeast of Cima. Photograph taken May 16, 1938.

flying up into a Joshua tree, where it was shot. On the same day another observer saw five Bendire thrashers, two of which were singing, in the open Joshua tree forest. On the following day, two juvenal birds, out of the nest and flying awkwardly, were seen in the lower branches of Joshua trees, and a recently evacuated nest was found in the vicinity. On May 15 a nest containing four young, which were being fed by both parents, was discovered in a dense, isolated cholla (*Opuntia ramosissima*) at the edge of a clearing in the Joshua tree forest (figs. 39 and 40). When the nest was approached for photographing on the following day (May 16), two of the young thrashers were already out of the nest, and another left at that time. The fourth was a runt, and was nearly dead. The rim of the nest was 15 inches above the ground. The outside diameter and the depth were each 10 inches; the nest cup was 5 inches wide and 3 inches deep. The nest was composed principally of thorny twigs and lined with dry fibers of Joshua tree leaves and with reddish brown cow hairs.

The second series of observations for 1938 took place in a similar habitat two miles east-southeast of Rock Spring, where on June 4 a nest containing four downy young thrashers, too young to identify with certainty, was found

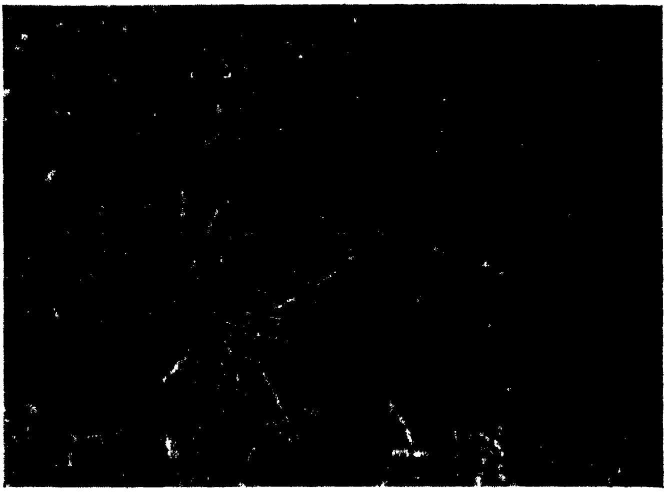


FIG. 40. Nest of Bendire thrasher (see fig. 39). Photograph taken May 16, 1938.

3½ feet above ground in a cholla. On the following day an adult female and a juvenal male Bendire thrasher, the latter barely able to fly, were taken at this locality. Several other thrashers, all thought to be of this species, were seen in the vicinity.

Toxostoma lecontei lecontei Lawrence
Leconte Thrasher

8 mi. W Clark Mt., May 25-28; 2½ mi. SW Kelso, June 19-21*; Colton Well, June 8*; 2 mi. SE Hidden Hill Mine, June 10*. Total specimens, 4. Two young-of-the-year were shot by Stephens (1903:105) at the base of the Providence Mountains near the end of May, 1902 Early in June, 1905, Hollister (1908:461) saw two Leconte thrashers and took one among large creosote bushes in Ivanpah Valley.

The four localities at which we found Leconte thrashers were all in the creosote bush belt at elevations between 2,100 and 3,500 feet. We found them only in the summer.

In the sand dune area southwest of Kelso these thrashers stayed along the washes where there were clumps of desert willow and unusually large creosote bushes. Before sunrise on June 20, 1940, one perched on the roof of our tent and gave several loud, clear call notes, each rising in pitch at the end. On the same day two young thrashers were shot from a family group of six. When pursued, they alternately ran and flew among high creosote bushes beside a wash, apparently reluctant to venture out into the lower bushes on the adjacent flat.

Eight miles west of Clark Mountain on May 25 and again on May 28, 1939, Leconte thrashers were present in family groups along a wash bordered with catclaw bushes.

Toxostoma dorsale dorsale Henry
Crissal Thrasher

Government Holes, May 27*; 5 mi. NE Granite Well, Jan. 5*; Mitchell's, Dec. 27*, June 10. Total specimens, 3.

Crissal thrashers were found in three places where there was fairly dense brush immediately below the piñon belt, at altitudes from 4,500 to 5,400 feet.

At Mitchell's on December 27, 1937, a pair of crissal thrashers was seen and a song was heard in the rocky and brushy area below the buildings. They were wary and elusive. An adult male was finally shot from a perch 6 feet up in a yucca. On the following June 10 a crissal thrasher was seen at close range at the same locality. It was flying down a rocky wash and was carrying food in its bill, presumably for young in a nest.

On January 5, 1938, an adult female was shot when it jumped to the top of a clump of sagebrush on the juniper-dotted flat five miles northeast of Granite Well, and another was seen in sagebrush some distance away. On May 27, at Government Holes, about 2 miles from the above locality, an immature male was first seen in high sagebrush, then shot when it flew to the top of a fence post.

These thrashers do not belong to the race *T. d. coloradense* recently described (van Rossem, 1946:80) from the Imperial Valley, and which initially was supposed to extend north along the Colorado River valley into Nevada. It now appears that this race is confined to the Colorado Desert of California and the Colorado River valley south of San Bernardino County.

Family Turdidae

Turdus migratorius Linnaeus
Robin

Robins were seen twice as migrants, the first time at Barnwell, where there were several on April 25, 1920, and the second time at five miles northeast of Granite Well on December 28, 1937, when one was heard calling, then seen flying out from a piñon-covered hill.

Hylocichla guttata guttata (Pallas)
Hylocichla guttata polionota Grinnell
Hermit Thrush

N side Clark Mt., 7,100-7,300 ft., May 20-29 (2 *polionota*); Cedar Canyon, May 25 (1 *polionota*); Mitchell's, Dec. 25 (1 *guttata*). Total specimens, 4.

Hermit thrushes were found both in winter (race *guttata*) and in summer (race *polionota*), but in very small numbers at both seasons.

A small breeding colony, estimated (Miller, 1940) to contain four pairs was discovered in 1939 in the fir forest on the northwest side of Clark Mountain, where hermit thrushes were heard in full and continuous song in late May. They stayed principally in the dense firs, but occasionally perched in piñons and junipers. The condition of the gonads and the behavior of two birds collected there indicated that nesting was in its early stages. These specimens,

together with a female taken on May 25, 1938, at Cedar Canyon (apparently not yet settled on its breeding grounds), are of the race *polionota*.

A lone adult male *H. g. guttata* was seen and shot on the evening of December 25, 1937, near a spring in the brushy canyon bottom above Mitchell's.

Hylocichla ustulata ustulata (Nuttall)
Swainson Thrush

N side Clark Mt., 5,000 ft., May 24*; SE side Clark Mt., 5,500-6,000 ft., May 21-22*; Mescal Cave, May 18*; Mitchell's, June 9*. Total specimens, 4.

These thrushes were present as migrants in the Providence Mountains area in the latter part of May and even as late as June 9. On Clark Mountain in 1939, individuals were seen flying from one piñon to another and along ravines where there were catclaw bushes and other shrubs. Most of the observations were made at elevations between 5,000 and 6,000 feet. It is noteworthy that no Swainson thrushes were seen at Cedar Canyon in the course of our work there at the same season in 1938. The latest date, June 9, is represented by an adult female, with ova not enlarged, that was taken in 1938 in the canyon above Mitchell's.

The four specimens taken belong unquestionably to the subspecies *ustulata*, not even approaching *almae* that breeds in the mountains of the Great Basin.

Sialia mexicana bairdi Ridgway
Mexican Bluebird

N side Clark Mt., 7,100-7,400 ft., May 17-29*; Cedar Canyon, Jan. 5-7*; 5 mi. NE Granite Well, Dec. 28–Jan. 5*; Mitchell's, Dec. 24-27*. Total specimens, 13.

In the winter, many small bands of Mexican bluebirds foraged about the bases of the mountains. In the summer an estimated three pairs (see Miller, 1940) bred in the Transition Zone fir forest on Clark Mountain.

The wintering flocks contained up to 20 individuals, and on at least one occasion, near Mitchell's on December 27, 1938, a few mountain bluebirds were mixed in with a flock of Mexican bluebirds. The birds foraged chiefly in open, more or less level areas. Below Mitchell's they found suitable foraging grounds among *Yucca mohavensis*, cholla cactus, and creosote bushes. Between periods of foraging, flocks flew about the cliffs above Mitchell's house and alighted on the tops of rocky pinnacles. Northeast of Granite Well they foraged on sagebrush flats among junipers and drank frequently at a water tank at Stott's ranch.

Sialia currucoides (Bechstein)
Mountain Bluebird

Cima, Jan. 3, 10*; Cedar Canyon, May 22*; Mitchell's, Dec. 27*. Total specimens, 8.

Mountain bluebirds were seen infrequently in midwinter and, as late migrants, in the early summer.

A male mountain bluebird was taken from a flock of Mexican bluebirds at Mitchell's on December 27, 1937. There appeared to be a few more of this species in the flock, which was foraging among chollas, yuccas, and creosote bushes. At Cima on the following January 3, a male and a female were perched

on telegraph wires near the railroad. On January 10 another female and three males were found at the same place, and other mountain bluebirds were seen near stock corrals in the vicinity.

On May 22, 1938, two mountain bluebirds, a male and a female, were seen and shot in Cedar Canyon. The birds were together, but it seems unlikely that they would nest in that region. The male was shot from a Joshua tree.

Myadestes townsendi townsendi (Audubon)
Townsend Solitaire

Clark Mt., Oct. 3; Pachalka Spring, Oct. 2 (1 specimen); Mescal Spring, Oct. 3.

Solitaires were numerous in October at Pachalka Spring and were noted at several places above 5,000 feet in or near the piñon belt in the northern part of the area at this season. None was detected in the winter of 1937-38.

Family Sylviidae

Polioptila caerulea amoenissima Grinnell
Blue-gray Gnatcatcher

N side Clark Mt., 5,000-7,300 ft., May 20-29; Pachalka Spring, May 31; SE side Clark Mt., 5,700-6,300 ft., May 16-22*; Mescal Cave, May 30; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 20-31*; Government Holes, May 27; Mitchell's, June 9; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 13.

These gnatcatchers were widely distributed in the summer, as pairs and lone individuals, over most of the area above the creosote bush association. They were best represented in the piñon belt, where individuals were noted in piñons, junipers, sagebrush, and many unidentified shrubs. Below the piñons they were chiefly in canyons and along washes, where they kept to brushy places, but at the mouth of Cedar Canyon they were on exposed hillsides among Joshua trees, *Yucca mohavensis*, and various kinds of cactus. High on the north side of Clark Mountain, gnatcatchers invaded the small area of white fir forest.

The habit on the part of the males of singing loudly and persistently in their breeding territories made gnatcatchers more conspicuous than most other small birds.

This species nested late in the season. A pair was building a nest on the southeast side of Clark Mountain, at 6,300 feet, on May 18, 1939. The site was 3½ feet above the ground in a shrub growing near a bluff in a small ravine. Both birds were working on the nest. A female taken on June 11 in the pass between the Granite Mountains and the Providence Mountains contained large ova. We had seen no young-of-the-year by that date.

Regulus calendula cineraceus Grinnell
Ruby-crowned Kinglet

Clark Mt., Oct. 3; Pachalka Spring, Oct. 2; SE side Clark Mt., 6,000 ft., May 21*; Mescal Spring, Oct. 3; Cedar Canyon, Jan. 5*; 5 mi. NE Granite Well, Dec. 29–Jan. 5*. Total specimens, 6.

In the winter a few ruby-crowned kinglets foraged through the piñon woods. Usually they were in piñons, but at five miles northeast of Granite Well one

was seen on January 4, and another on January 5, 1938, in a dense, isolated clump of oak trees. On two occasions kinglets were seen foraging in the midst of flocks of bush-tits, once in oak trees and once in junipers and sagebrush. All the other kinglets seen were solitary. A late spring migrant, a female in worn plumage, was taken at 6,000 feet altitude on the southeast side of Clark Mountain on May 21, 1939. The six specimens taken include nearly all the individuals that were noted. Apparently the species does not breed in the area.

The midwinter birds, in fairly fresh plumage, are here referred to the race *cineraceus* on the basis of slightly paler color and a tendency toward grayness on the back, as contrasted with specimens of *R. c. calendula* from the northeastern United States. In this respect they agree closely with birds collected in winter along the lower Colorado River and assigned to *cineraceus* on much the same grounds by Grinnell (1914:213). Both the Providence Mountains and Colorado River series are paler than series from localities in coastal California and the northern Great Basin, thus possibly representing an extreme expression of the characters of *cineraceus*. The plumage of the May-taken specimen from Clark Mountain is too worn for useful comparison.

Family MOTACILLIDAE
Anthus spinoletta pacificus Todd
Water Pipit

Two pipits, both adult males, were taken on January 9, 1938, in the Joshua tree area three miles north of Cima. One was foraging on a tiny patch of grass kept green by the overflow from a water trough in a stock corral. The other was walking about on the muddy, trampled ground inside a similar corral.

Family BOMBYCILLIDAE
Bombycilla cedrorum Vieillot
Cedar Waxwing

Pachalka Spring, May 28, 31*; Cedar Canyon, May 26*. Total specimens, 7.

Two cedar waxwings were perched in desert willows in the narrowest part of Cedar Canyon (fig. 11) on May 26, 1938. One that was collected proved to be a male with testes 3 mm. long.

On May 28 and May 31, 1939, cedar waxwings were seen at Pachalka Spring. On the latter date a band of approximately 25 individuals was flying about and perching in willow trees near the spring. Three females collected then contained enlarged ova; in one bird the ovary measured 10 mm.

Family PTILOGONATIDAE
Phainopepla nitens lepida Van Tyne
Phainopepla

8 mi. W Clark Mt., May 28; N side Clark Mt., 5,000 ft., May 24-27*; S side Clark Mt., 5,000-5,400 ft., May 20-22; Mescal Spring, May 30; 5 mi. NE Granite Well, Dec. 31–Jan. 6*. Total specimens, 7. Stephens (1903:104) saw phainopeplas in small numbers at the base of the Providence Mountains in 1902.

Phainopeplas were present in May and in midwinter, although according to our records less abundantly at the latter season. About the base of Clark

Mountain in 1939 they stayed mostly along washes where there were desert willows and catclaw bushes and perched occasionally in Joshua trees. They seemed most numerous on the north side of the mountain. Four phainopeplas were flying southward, close together, as though in migration, over a juniper-dotted slope on the south side of Clark Mountain on May 22.

A nest with three eggs examined 8 miles west of Clark Mountain on May 28, 1939, was 6 feet above ground in a crotch of a desert willow. At 9:30 and again at 11 a.m., the female was on the nest and the male was perched nearby, calling.

The winter records pertain to two birds that were taken in early January, 1938, near Stott's ranch house, five miles northeast of Granite Well. An adult male in glossy black plumage was quite wary. It perched regularly in the tops of juniper trees, sometimes in the midst of a band of Mexican bluebirds, and made frequent flycatcher-like sallies out into the air. An immature male in mottled postjuvenal plumage was much less wary.

Family Laniidae

Lanius ludovicianus nevadensis Miller

Lanius ludovicianus gambeli Ridgway

Loggerhead Shrike

8 mi. W Clark Mt., May 28-29 (3 *nevadensis*); SE side Clark Mt., 5,000 ft., May 22 (2 *nevadensis*); Nipton, Jan. 10; Ivanpah Lake, March 29; Purdy, May 30; 3 mi. N Cima, Jan. 9-12 (1 *nevadensis*, 1 *gambeli*), May 14 (1 *nevadensis*); 2 mi. NNE Cima, May 12-17 (5 *nevadensis*); Cima, May 14; 5 mi. SE Cima, May 21-23; 5 mi. N Kelso Peak, Dec. 14; Cedar Canyon, Jan. 7-8, May 21–June 4 (2 *nevadensis*); 2 mi. ESE Rock Spring, June 6 (1 *nevadensis*); 5 mi. NE Granite Well, Dec. 27-30 (1 *nevadensis*); 3 mi. S Granite Well, Dec. 21 (1 *gambeli*); 6 mi. S Granite Well, Dec. 18-24 (1 *nevadensis*, 1 *gambeli*); Colton Well, June 7 (1 *nevadensis*); Mitchell's, Dec. 25; 2½ mi. SW Kelso, June 18-23; Snake Spring, June 24; pass between Granite Mts. and Providence Mts., June 11, Oct. 7. Total specimens, 21.

Shrikes were conspicuous inhabitants of the lower, unforested part of the area, including the creosote bush and yucca belts. None was seen above 5,400 feet, nor anywhere within the piñon belt. They were not abundant at any one place, but individuals, pairs, or family groups were scattered with monotonous regularity over the broad alluvial fans. Shrikes were noted perching most frequently in Joshua trees, desert willows, and *Yucca mohavensis*, less frequently in junipers, creosote and catclaw bushes, and saltbush, and on prominent boulders. One habitat requirement seemed to be the presence of bare ground for foraging; thus at five miles northeast of Granite Well, where sagebrush grew in dense stands, only one shrike was found, and it was at the edge of an artificial clearing. Shrikes showed remarkable ability to endure extremes of temperature. Foraging individuals were abroad, perched in exposed places, in the piercing wind at near-freezing temperature in December, and likewise in direct sunlight on the hottest days in June when birds of other species had sought shade.

Nesting was well under way by the middle of May in 1938. The first nest we found, on May 14, was in a low, dense Joshua tree near Cima; it had re-

cently held young, as was shown by the presence of feather scales. A nest 5 miles southeast of Cima contained two young shrikes, not yet feathered out, and an unhatched egg on May 21. The nest was seven feet above ground in a Joshua tree and was composed of thorny twigs and lined with the fibers of decayed Joshua tree leaves (fig. 41). On May 27 there was a single fresh egg in a nest 10 feet above the ground in a juniper at the head of Cedar Canyon.

FIG. 41. Loggerhead shrike feeding young in nest in Joshua tree 5 miles southeast of Cima. Photograph taken May 22, 1938.

This nest consisted of an outer layer of twigs and small branches and a lining of hair and other fine material.

Family groups, including parents and four or five young shrikes recently out of the nest, were observed as follows: near Cima on May 17, 1938; at Colton Well on June 7, 1938; at 2½ miles southwest of Kelso from June 18 to 23, 1940. The last-mentioned group was stationed in a clump of desert willows beside a wash. Our camp was established in the shade of this willow clump for five days, and in that time the young shrikes did not venture away from this place.

On May 15, 1938, near Cima, a pair of shrikes that probably had a nest nearby "mobbed" a Swainson hawk perched in the top of a Joshua tree without appearing to disturb the hawk.

The breeding birds listed as *nevadensis* from the vicinity of Cima in a few instances approach or equal *sonoriensis* in length of tail, thus indicating the beginning of intergradation which is more evident south of the Providence Mountains area. The population as a whole corresponds most closely with *nevadensis*. Migrant shrikes of the race *gambeli* augmented the resident population in winter.

Family VIREONIDAE

Vireo vicinior Coues

Gray Vireo

N side Clark Mt., 5,500 ft., May 24*; SE side Clark Mt., 5,800-6,300 ft., May 16*; Cedar Canyon, May 21–June 2*. Total specimens, 10. Stephens (1903:104, under account of "*Vireo pusillus*") thought he heard gray vireos in the Providence Mountains in 1902.

In late May and early June, 1938, gray vireos were conspicuous, though not abundant, near Cedar Canyon. Suitable habitat was provided by sagebrush (*Artemisia tridentata*), where this shrub grew in high and relatively compact

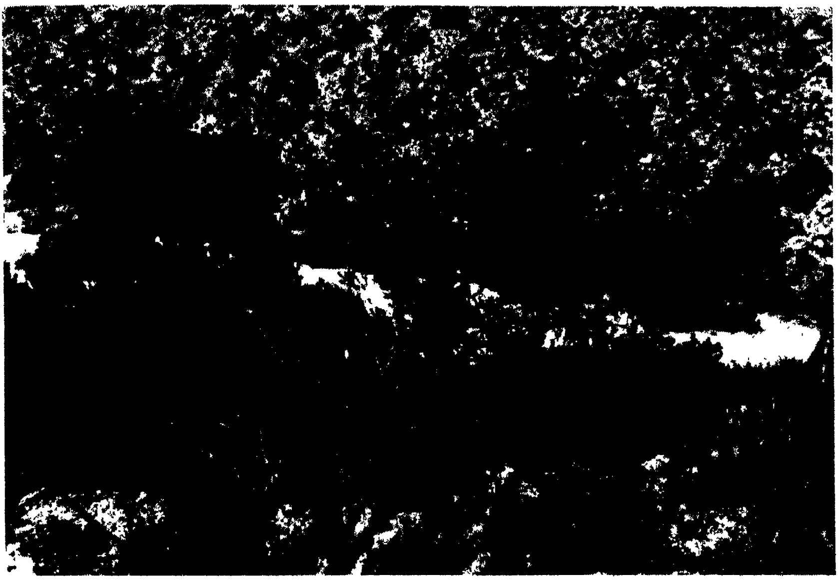


FIG. 42. Nesting habitat of gray vireo in lower piñon belt. A nest was situated in the piñon at right of picture. Photograph taken May 26, 1938, at Cedar Canyon.

stands interspersed with piñons and junipers. Other plants in which gray vireos perched include desert thorn (*Lycium* sp.) and ephedra. The piñons served as observation and singing posts and, at least on one occasion, for nesting (fig. 42). Most of the gray vireos were found in the area of low hills at 5,500 feet altitude within two miles north of Cedar Canyon; near our base camp at 5,000 feet they were less abundant. The loud song made detection of breeding pairs easy. On May 29, 1938, it was estimated by Grinnell that there were four pairs of gray vireos to a square mile in favorable terrain, a number considerably lower than the 16 pairs to a square mile estimated by the same observer (see Grinnell and Swarth, 1913:293) in *Adenostoma* association in the San Jacinto Mountains.

A nest in a four-foot-high clump of sagebrush on the south side of Cedar Canyon contained four fresh eggs on May 24. The nest (figs. 43 and 44) was 29 inches from the ground; it measured, on the outside, 2⅜ inches both in depth and in diameter. The inside cup was 1⅞ inches in diameter and 2 inches

Fig. 43. Gray vireo incubating at nest in sagebrush in Cedar Canyon. Photograph taken May 24, 1938.

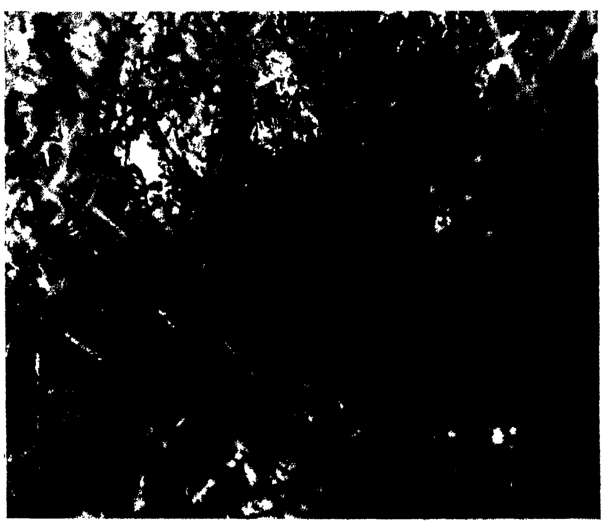


Fig. 44. Nest and eggs of gray vireo. Same nest as in figure 43. Photograph taken May 26, 1938.

deep. The framework consisted mainly of thin shreds of sagebrush bark; the lining was of fine grass and a feather. An incubating parent allowed a close approach. Another nest, incomplete on May 26, was 5 feet above the ground in a small piñon (fig. 42). It was attached to limbs varying from ¼ to ¾ inch in diameter. This nest, as yet unlined, was made of shredded juniper bark, grass fibers, and parts of spider egg cases. Spider webs had been used for binding.

Three gray vireos were taken at elevations between 5,500 and 6,300 feet on Clark Mountain in the spring of 1939. We found none in the winter.

Vireo solitarius cassinii Xantus
Solitary Vireo

N side Clark Mt., 5,000 ft., May 26*; SE side Clark Mt., 6,300-7,000 ft., May 18-23*; Cedar Canyon, May 22*. Total specimens, 6. Stephens (1903:104) found solitary vireos "not common" at 5,000 to 6,000 feet altitude in the Providence Mountains in 1902.

The few solitary vireos that we came across were apparently all spring migrants. Individuals were seen, singly, at elevations between 5,000 and 7,000 feet. There was no evidence of the species nesting in the area; our latest record is May 26. The testes of the two males taken May 18 and 19 were slightly enlarged (4 mm. long). Another male was singing in a juniper among rocks on a steep hillside at 6,300 feet on the southeast side of Clark Mountain on May 23.

In the series of six specimens there is a male, taken May 18, 1939, on the southeast side of Clark Mountain, with an abnormal bill. The tip of the upper mandible is prolonged and curved downward and slightly to the left; it extends 4.5 mm. beyond the tip of the lower mandible, whereas normally the difference is less than 1 mm. The upper part of the bill is deformed at the base, about the nostrils, as though it had been injured at some time. As the bird was fat and its plumage in good condition, it must not have been handicapped in feeding and preening.

Vireo gilvus leucopolius (Oberholser)
Warbling Vireo

SE side Clark Mt., 6,300 ft., May 18*; Mescal Cave, May 30*; Cedar Canyon, May 22–June 2*. Total specimens, 8. Warbling vireos were heard in the Providence Mountains in 1902 by Stephens (1903:104).

These vireos were present as spring migrants at elevations between 5,000 and 6,300 feet; we found no evidence that they were breeding. The latest record is of a male, with testes not enlarged, taken north of Cedar Canyon on June 2. Individuals were seen in or near piñons, junipers, and Joshua trees.

In subspecific identification we have followed Sibley (1940).

Family Parulidae

Vermivora celata orestera Oberholser
Orange-crowned Warbler

The three records of orange-crowned warblers represent spring and fall migrants. On May 15, 1938, one was flying from bush to bush near the mouth of a rocky canyon five miles southwest of Ivanpah, and on May 21, 1939, a male with testes 4 mm. long was shot on the southeast side of Clark Mountain. On October 2 one was taken in catclaws at Rock Spring.

Vermivora virginiae (Baird)
Virginia Warbler

NW side Clark Mt., 7,300 ft., May 20 (2 specimens), May 24, May 29.

The presence of a small breeding population of Virginia warblers in the white fir area on the northwest side of Clark Mountain has already been described by Miller (1940:163; by inadvertence under the name "*Dendroica virginiae*"). There are no further records from the Providence Mountains area, and it seems unlikely that the species would find a suitable habitat outside the restricted fir association. One male had a beat near the base of the cliffs in open firs and piñons, with open tracts of shrubs between. Another was in the lower limit of the area on a slope with piñons and service berry, but just across from a small patch of firs which it occasionally visited. The entire breeding population was estimated to consist of four pairs.

Dendroica aestiva morcomi Coale
Yellow Warbler

A yellow warbler was singing among dense green bushes and junipers in a wash bottom at Cedar Canyon on May 20, 1938. On the following day an adult male, possibly the same bird, was shot at that place. No other yellow warblers were found in the area. The bird taken was undoubtedly a spring migrant. It has the combination of dark greenish back and broad streaks on the breast characteristic of the race *morcomi*.

Dendroica auduboni auduboni (Townsend)
Audubon Warbler

NW side Clark Mt., 7,300 ft., May 20, Oct. 3; Pachalka Spring, Oct. 2 (1 specimen); SE side Clark Mt., 6,300 ft., May 17-19; Mescal Spring, Oct. 3.

A few migrant Audubon warblers were seen or heard on Clark Mountain between May 17 and May 20, 1939, both in the piñons on the southeast side and in the white firs on the northwest side. There may have been a resident pair at the latter place. In the fall, migrant individuals were numerous at Pachalka Spring.

We do not find the proposed race *D. a. memorabilis* of the Rocky Mountain region usefully separable from *D. a. auduboni*.

Dendroica nigrescens (Townsend)
Black-throated Gray Warbler

N side Clark Mt., 5,400-7,300 ft., May 20-29*; Pachalka Spring, Oct. 2; SE side Clark Mt., 6,300-7,500 ft., May 16-18*; Mescal Cave, May 30; Cedar Canyon, May 24-25*. Total specimens, 14. Stephens (1903:105) found this species to be "rather common in the higher parts of the Providence Mountains in June [of 1902]."

Although no nests or young of the species were found by us in the Providence Mountains area, there is good evidence that black-throated gray warblers nested throughout the piñon belt and in the white firs. The breeding population was probably supplemented by migrants during most of our spring

field work. Individuals were observed and specimens taken in spring at elevations between 5,000 feet (Cedar Canyon) and 7,500 feet (Clark Mountain). Most of them were in trees, principally piñons; a few were in shrubs.

Singing males were perched in piñons at widely spaced stations along the sides of a canyon on the southeast side of Clark Mountain on May 18, 1939. On May 20, the white firs at 7,300 feet on the northwest side of the mountain were found to be well populated with black-throated gray warblers. Among these taller trees they stayed in the lower branches and in the understory shrubs.

Of three females taken on May 24, two had eggs in their oviducts and the third had a brood patch. On the same date a male had testes 7 mm. long.

Dendroica townsendi (Townsend)
Townsend Warbler

8 mi. W Clark Mt., May 28; NW side Clark Mt., 7,300 ft., May 20*; near summit Clark Mt., May 17; SE side Clark Mt., 6,300 ft., May 18-19; Mescal Cave, May 18*; Cedar Canyon, May 21*. Total specimens, 3.

Migrant Townsend warblers were seen as late as May 21 in 1938 and May 28 in 1939. They were mostly at high elevation, in piñons, junipers, or white firs.

Dendroica occidentalis (Townsend)
Hermit Warbler

A solitary female hermit warbler, shot on May 19, 1939, at 7,000 feet altitude in the thickest grove of piñons and junipers on the southeast side of Clark Mountain, was undoubtedly a spring migrant. It was fat.

Oporornis tolmiei (Townsend)
Tolmie Warbler

N side Clark Mt., 5,000 ft., May 26*; SE side Clark Mt., 6,300 ft., May 17*; Mescal Cave, May 30; Cedar Canyon, May 24-30*. Total specimens, 8.

Tolmie warblers passed through the area in the spring migration during the last part of May. They were seen at altitudes between 5,000 and 6,300 feet. At Cedar Canyon in 1938, both males and females were present, the former apparently in greater numbers. They stayed close to the ground, flitting elusively and silently from bush to bush in washes and canyon bottoms. One was shot from a clump of rabbit brush; another, at Mescal Cave, was in desert thorn (*Lycium*). In 1939, on Clark Mountain, the four specimens that were taken and all the other individuals plainly seen were females.

Icteria virens (Linnaeus)
Chat

A migrant chat was seen traveling northwestward down Cedar Canyon by two observers late in the afternoon of May 23, 1938. It perched once in a bush and once in a low juniper.

Wilsonia pusilla pileolata (Pallas)
Pileolated Warbler

N side Clark Mt., 7,300 ft., May 20; Pachalka Spring, June 1*, Oct. 2*; SE side Clark Mt., 5,000-6,300 ft., May 17-22*; Mescal Cave, May 18*; Cedar Canyon, May 20–June 2*; Rock Spring, Oct. 6*. Total specimens, 13.

Our spring field work in 1938 and 1939 was early enough to catch the last of the migrating pileolated warblers. At Cedar Canyon they were numerous on May 20, 1938, and thereafter were seen in fewer numbers; the latest of the season, an abnormally lean female, was taken on June 2. Near Mescal Cave many were seen in the canyon bottom on May 18, but none was apparent when the place was revisited on May 30. On May 18 and 20, 1939, they were noted as "abundant" on Clark Mountain; on May 21 the numbers seemed fewer, and the last noted that season, a female, was at Pachalka Spring on June 1. The latest date for a male was May 21, 1938.

These warblers stayed principally in thick brush in canyon bottoms and along washes. On the north side of Clark Mountain they were singing, though not with maximum volume, on May 20.

In the fall, migrants were detected in early October.

Family Ploceidae

Passer domesticus domesticus Linnaeus
House Sparrow

Valley Wells, June 1; Mountain Pass, May 23; Ivanpah, May 30; 3 mi. N Cima, May 12-14; Cima, May 30; Kelso, June 21, Jan. 3 (2 specimens), Oct. 7.

House sparrows were well established at human settlements along the Union Pacific Railroad and along U. S. Highway 66. Both these arteries for human transporation seemed to serve for house sparrows as well. At the Williams Ranch, three miles north of Cima, they were noisy, conspicuous, and evidently nesting in May, 1938. This place is on a well-traveled dirt road connecting the railroad at Cima and the highway at Valley Wells.

The largest flock noted was at Kelso, where on January 3, 1938, there were about 100 house sparrows with headquarters in the tall cottonwoods; they foraged in trash on the ground. Two males were taken from this flock. On June 21, 1940, house sparrows were seen near the sewer outlet on the desert southwest of the town. Several pairs were living around the gasoline station at Mountain Pass on May 23, 1939, and there were at least five pairs near the buildings at the Valley Wells service station on June 1, 1938.

Family Icteridae

Sturnella neglecta Audubon
Western Meadowlark

Meadowlarks were extremely rare in the area, although they were noted both in winter and in summer. Of the two individuals seen, the first specimen taken was in an area of scattered brush, with sparse grass growing in the openings,

near Granite Well on December 20, 1937. The second was near the "oasis" at the Kelso sewer outlet on June 21, 1940.

Agelaius phoeniceus sonoriensis Ridgway
Red-winged Blackbird

A female red-winged blackbird, definitely of the subspecies *sonoriensis*, was shot 2 miles north-northeast of Cima on May 12, 1938. It was near an open-topped water tank in the Joshua tree belt and was accompanied by a male cowbird.

Icterus cucullatus californicus (Lesson)
Hooded Oriole

Mescal Spring, May 30*; ¾ mi. E Cima, May 16*; Cedar Canyon, May 20. Total specimens, 2.

Hooded orioles were seen at three places. Along a shallow wash east of Cima a pair stayed close about a clump of desert willows on May 16, 1938. When driven out, the female would hide in nearby bushes for a short while, then return again and again to the willow clump. No nest could be found there. On May 20 a male was seen in desert willows in Cedar Canyon. Another male was seen and shot on the morning of May 30, 1939, when it came to drink at a trough at Mescal Spring. It was in full breeding condition, with testes 12 mm. long.

These birds are typical of *californicus* rather than of the clear yellow *nelsoni* which ranges west to the lower Colorado River valley (van Rossem, 1945*b:* 242).

Icterus parisorum Bonaparte
Scott Oriole

N side Clark Mt., 5,400-5,500 ft., May 24-25*; NW side Clark Mt., 7,300 ft., May 20; SE side Clark Mt., 5,000-6,300 ft., May 16-22*; Mescal Spring, May 29-30*; 5 mi. SW Ivanpah, May 15; Purdy, April 26-27, May 30; 2 mi. NNE Cima, May 13-16*; Cedar Canyon, May 20–June 2*; Government Holes, May 27; Colton Well, June 7*; Mitchell's, June 8*. Total specimens, 18.

Scott orioles were far more abundant than either of the other species of *Icterus*. They occupied a broad vertical range and were found under a variety of environmental conditions. Altitudinally, they ranged from 3,200 feet (at Colton Well) to 7,300 feet (on the northwest side of Clark Mountain), and zonally from the creosote bush belt through the piñon belt and sporadically to the white fir area. The greatest numbers were at middle elevations, as at Cedar Canyon and at about 5,400 feet on the southeast side of Clark Mountain, where Joshua trees, junipers, and piñons were intermixed, and where there were intervening brushy areas on slopes and benches. Scott orioles were noted most frequently in Joshua trees and commonly in junipers and piñons, but at Colton Well, where none of these trees was present, *Yucca mohavensis* served for perching and probably for nesting.

At Cedar Canyon on May 13 a Scott oriole was pecking at blossoms of a cactus. At Mescal Spring and at Mitchell's individuals came to open water tanks to drink.

A nest found on May 22, 1939, at 5,000 feet on the southeast side of Clark Mountain contained four well-incubated eggs. It hung between two limbs in the center of a dense Joshua tree, where it was concealed from view and well protected from wind and sun. The nest is bowl shaped, slightly wider than deep and with the greatest diameter below the rim, which is somewhat constricted and low on one side. The outside depth is 100 mm.; the outside diameter 130 mm.; the cup is 70 mm. deep and 95 mm. in diameter. The nest is made principally of closely woven fibers of Joshua tree leaves, which impart considerable rigidity to the structure. The lining is of finer fibers of the same material, interwoven with a piece of cotton string and a few bits of paper. A nest similarly situated and constructed at Cedar Canyon contained three downy young orioles on June 2, 1938. Other nests at Cedar Canyon, unoccupied on May 21, were in junipers and piñons.

Icterus bullockii bullockii (Swainson)
Bullock Oriole

Near summit Clark Mt., May 17; SE side Clark Mt., May 19 (1 specimen); 3 mi. N Cima, May 12.

Bullock orioles were seen only in mid-May, and even then they were scarce. We found no evidence of their breeding in the area; our records may all be of spring migrants. One was seen among scattered piñons near the crest of Clark Mountain on May 17, 1939, and two days later a female was shot at 6,300 feet altitude on the southeast side of the mountain. A Bullock oriole was about the buildings at the Williams Ranch, 3 miles north of Cima, on May 12, 1938, but none was seen there subsequently.

Molothrus ater obscurus (Gmelin)
Molothrus ater artemisiae Grinnell
Cowbird

SE side Clark Mt., 6,300 ft., May 19; 3 mi. N Cima, May 12 (1 *obscurus*, 1 *artemisiae*); 2 mi. NNE Cima, May 12 (1 *obscurus*); Cedar Canyon, May 20–June 4 (2 *obscurus*); Government Holes, May 27 (1 *obscurus*). Total specimens, 6.

Cowbirds were found at elevations between 4,100 and 6,300 feet. At the head of Cedar Canyon, from one to six were to be seen almost daily, perched on the backs of grazing range cattle or foraging on the ground near by. On May 27, 1938, a drowned cowbird was in a water tank at Government Holes and two others were foraging in an adjacent corral. On May 12, 1938, two cowbirds, a male *obscurus* and a female *artemisiae*, were shot from a tree at the Williams Ranch, 3 miles north of Cima, and on the same day a male *obscurus* that was accompanying a female red-winged blackbird was shot at a water tank 2 miles north-northeast of Cima. A cowbird perched in the top of a dead piñon on the southeast side of Clark Mountain on May 19, 1939, repeatedly gave a loud, clear whistle-like call. A female taken on June 4 had enlarged ova.

The specimens taken are all of the small subspecies *obscurus*, except the female (no. 74400) from the Williams Ranch, which is larger (wing 100.1 mm., tail 69.0 mm., culmen 16.1 mm., weight 40.5 grams) and was probably a migrant.

Family Thraupidae

Piranga ludoviciana (Wilson)

Western Tanager

8 mi. W Clark Mt., May 26; NW side Clark Mt., 7,300 ft., May 28-29; S and SE sides Clark Mt., 5,000-7,000 ft., May 18-22*; Mescal Spring, May 30*; Mescal Cave, May 18*, May 30; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, May 20-31*; Government Holes, May 27. Total specimens, 10. Stephens (1903:104) reported that "a few Louisiana tanagers were seen on the Providence Mountains" in 1902.

Western tanagers were common as spring migrants, and a few pairs may have stayed to breed in the Transition Zone area on Clark Mountain. We saw them at elevations as low as 3,300 feet, mostly in brushy places near the bases of the mountains. They perched in piñons, junipers, and yuccas, but foraged principally in shrubs.

A band of eight tanagers was foraging on the ground and in low bushes, including sagebrush and ephedra, along a wash on the southeast side of Clark Mountain on May 22, 1939. They moved steadily down the wash for a distance of several hundred yards, the birds in the rear flying up to the front so that the group moved along much like a flock of bush-tits. None of the birds collected up until May 30 had enlarged gonads. Males were singing on several dates, beginning May 20. At Cedar Canyon on May 24 and at Mescal Spring on May 30, tanagers came to drink at open water.

Family Fringillidae

Pheucticus melanocephalus melanocephalus (Swainson)

Black-headed Grosbeak

N side Clark Mt., 7,100-7,400 ft., May 24-29*; SE side Clark Mt., 6,300 ft., May 17*; S side Clark Mt., 5,000 ft., May 22; Mescal Spring, May 30*; Mescal Cave, May 30; Cedar Canyon, May 28-31*. Total specimens, 9.

Black-headed grosbeaks were present as spring migrants, and possibly also as summer residents, in the more heavily wooded parts of the area at and above 5,000 feet altitude. They were most frequently seen on shaded, north-facing slopes and in the vicinity of surface water. Individuals were noted specifically in piñons, white firs, and a desert thorn bush.

Because most of the places in which black-headed grosbeaks were seen appeared unfavorable as breeding sites for the species, we supposed that the birds were late migrants, but observation seemed to indicate that these grosbeaks were already on or near their breeding grounds. A male that was shot among the white firs on Clark Mountain on May 24 had testes 13 mm. long, and other males were singing there on the evening of May 28 and at Cedar Canyon on May 30. A male and a female at Cedar Canyon on the latter date were evidently paired.

The series of nine specimens has been referred to the subspecies *melanocephalus* chiefly on the basis of large bill size. One female (no. 74471) taken at Cedar Canyon on May 28, 1938, has a relatively small bill and may represent a migrant of the coastal race *maculatus*, but it can be matched among speci-

mens from the Panamint Mountains, within the western part of the breeding range of *melanocephalus*.

Passerina amoena (Say)

Lazuli Bunting

Two of the three records of lazuli buntings probably pertain to migrants. They include a female shot on May 15, 1938, in a deep, rocky canyon 5 miles southwest of Ivanpah and another female, fat and with small ova, that was shot May 28 in a bush in the hilly area on the south side of Cedar Canyon. A pair may have been nesting at Pachalka Spring, where a grove of willow trees, some elderberry bushes, a peach orchard, and a small area of open water simulated the usual habitat of lazuli buntings. A male was seen there on May 31, 1939, and a female collected the following day had a brood patch.

Hesperiphona vespertina brooksi Grinnell

Evening Grosbeak

An adult female evening grosbeak, evidently a vagrant, was taken in the fir forest on the north side of Clark Mountain on May 24, 1939.

Carpodacus cassinii Baird

Cassin Finch

Cedar Canyon, Jan. 6; 5 mi. NE Granite Well, Dec. 27–Jan. 2 (7 specimens).

These finches were present as winter visitants chiefly in the sagebrush-juniper area above 5,000 feet altitude in the Mid Hills section of the Providence Mountains. In the vicinity of Stott's house, five miles northeast of Granite Well, they were especially abundant. Solitary individuals and small flocks foraged in piñons on rocky hillsides and in junipers on the adjacent flats. The largest flock, seen on January 2, contained 39 birds. Sometimes these finches perched quietly for long periods in the centers of junipers.

Carpodacus mexicanus frontalis (Say)

House Finch

N side Clark Mt., 5,500-7,400 ft., May 20-24*; Pachalka Spring, May 28, 31*; S and SE sides Clark Mt., 5,000-7,000 ft., May 16-22*; Mescal Spring, May 23, May 30; Mescal Cave, May 18, May 30, Oct. 4; Valley Wells, June 1; Ivanpah Lake, March 29; 3 mi. N. Ivanpah, April 25; 5 mi. SW Ivanpah, May 15; 1 mi. N Barnwell, May 30; Purdy, April 26-27; 3 mi. N Cima, May 14, Jan. 9-12*; 2 mi. NNE Cima, May 12-19*; Cedar Canyon, May 20–June 3*; 2 mi. ESE Rock Spring, June 4-5; 2 mi. NE Kelso, Jan. 3; Kelso, June 21, Oct. 7; 2½ mi. SW Kelso, June 22*; Mitchell's, June 8-10*; Snake Spring, June 23; pass between Granite Mts. and Providence Mts., June 11. Total specimens, 34. Hollister (1908:461) saw "a few" house finches on New York Mountain in June, 1902.

House finches were abundant residents. In the summer they were found at elevations from 2,100 to 7,400 feet, and were breeding at both extremes, apparently with little regard for zonal differences. The winter range was more restricted altitudinally; the highest record at that season was 4,500 feet.

Water to drink seemed to be a prime necessity at all seasons, and in this arid region natural water holes are so few and so far apart that the original

house finch population must have been small. At Cedar Canyon nesting pairs depended on the few gallons of water in several small residual pools in rocky side canyons. Near the summit of Clark Mountain they were nesting in cliffs above melting snow banks, and at Mescal Cave the only visible water was that dripping from a limestone ledge. At other places the finches took advantage of man-made watering places. Nearly all the springs in the area had been modified by human agency so as to increase both the volume of water and the extent of time it was available. At Snake Spring and at Mitchell's, house finches drank at open water-storage tanks placed near the original springs. In the vicinity of Cima, pipe lines laid by cattlemen extended for distances of four miles or more across the dry alluvial fans to a series of corrals, near which were large, open-topped storage tanks and low stock-watering troughs. About these corrals house finches were especially numerous. On January 12, 1938, a band of 60 or more individuals was seen in the Joshua trees and on the ground around one corral, and 20 birds at once were lined up and drinking on the rim of the tank. In the summer the concentration about the tanks was less noticeable, but nesting pairs scattered through the adjacent Joshua tree woods made frequent trips to drink. At Kelso, house finches were drinking at the sewer outlet just outside the town on June 21, 1940. In May and June, water was visited chiefly in the morning and in the evening, less frequently at midday.

Provided that water was nearby, house finches perched and foraged, apparently without discrimination, on the ground and in piñons, junipers, Joshua trees, willows, desert willows, chollas, and numerous shrubs. One that was shot near a pool above Mitchell's had its crop distended with a mash of seeds and water, and the crops of two taken on the south side of Clark Mountain contained green grass seeds.

For nesting they resorted to crannies in cliffs, as at Mescal Cave and on Clark Mountain, or built nests in Joshua trees and chollas. A nest 2 miles north-northeast of Cima was 8 feet from the ground near the tip of a Joshua tree branch. On May 16, 1938, it contained four eggs. There were likewise four fresh eggs in a nest, built 4 feet from the ground in a cholla, at Cedar Canyon on June 1. Both parents were in the vicinity, the female following after the apparently indifferent male, calling and begging to be fed like a young bird. This calling was continued even while the female was on the nest. Two young-of-the-year were recently out of the nest and being fed by a female at Cedar Canyon on May 20, 1938. A solitary juvenile was taken among desert willows southwest of Kelso on June 22, 1940.

In the light of the findings concerning color changes and molts of house finches at Pasadena, California, made by Michener and Michener (1931 and 1940) and the statement by van Rossem (1936:52-53) that in the Charleston Mountains males in the first winter retain the female type of plumage, it is worth recording the color variation within our Providence Mountains series. Of the seventeen winter-taken birds, all collected near Cima between January 9 and 12, 1938, ten are males and seven are females. All the males show some reddish pigment, which varies in extent and color so that three groups may be

distinguished, as follows: (1) 7 individuals are reddish on head, back, breast, and rump, with a color that approaches Carmine (this and subsequent capitalized color terms are from Ridgway, 1912) on the forehead, where it is most concentrated but where it is more or less dulled by grayish terminal barbules; two individuals in this group have a few yellowish feathers on the throat and breast. (2) One individual has the pigment distributed almost as widely as in the first group, but the color is more orange, between Flame Scarlet and Mars Orange, on the forehead. (3) Two individuals have the pigment distributed in much the same way as the others, but the color is so faint and so dominated by the dusky streaking that only on the rump can it be seen at first glance; the color seems to be nearer the deeper red of the first group, although in one individual it is slightly orange. In the series of 15 specimens in worn breeding plumage, 11 are males taken between May 31 and June 10, 1938, and between May 19 and 31, 1939. These may be divided into the same groups as the winter birds, and each group is represented by approximately the same proportion of individuals, as follows: (1) Seven have the deep reddish Carmine pigment, less obscured than in winter; four of these have scattered orange feathers on the throat and breast. (2) One has yellowish pigment, between Light Cadmium and Analine Yellow, with a few orange feathers interspersed on the forehead and the throat. (3) Three have the pigment restricted and intermediate in color between the two other groups. It seems likely that at both seasons the finches in group 1 include the "middle-aged," sexually mature males; those in group 2 either old or abnormal males; and those in group 3 males that were sexually immature when the plumage was attained.

Spinus pinus pinus (Wilson)
Pine Siskin

N side Clark Mt., 7,300-7,400 ft., May 20, 28 (2 specimens); summit Clark Mt., May 17; Cedar Canyon, May 21.

Pine siskins were numerous among the white fir trees on the north side of Clark Mountain, and two females were collected there on May 28, 1939. It is uncertain whether they remained to nest. A siskin, undoubtedly a migrant, was seen flying in typical undulating fashion over Cedar Canyon on May 21, 1938.

Spinus psaltria hesperophilus (Oberholser)
Arkansas Goldfinch

8 mi. W Clark Mt., May 28*; N side Clark Mt., 5,500 ft., May 24*; Pachalka Spring, May 28, May 31–June 1*; Mescal Spring, May 30*; Cedar Canyon, May 20–June 3*; Mitchell's June 9-10*. Total specimens, 9.

These goldfinches were present and apparently nesting in late May and early June. Our records show an altitudinal range from 3,300 to 5,500 feet. Individuals probably occurred at higher elevations, but in general the species seemed to be restricted to the areas about the bases of the mountains, where springs and pools provided drinking water. The goldfinches made up a small but consistent minority among the swarms of mourning doves and house finches that came to drink wherever there was open water.

Except in the vicinity of water, they were wary and elusive, and we learned little of their habits. Individuals were seen in piñons, willows, and junipers. At Cedar Canyon on May 20, 1938, they were heard singing and one was seen carrying nest material. A male taken at Mescal Spring on May 30, 1939, had testes 6 mm. long, and a female at Mitchell's on June 9, 1938, had slightly enlarged ova.

Loxia curvirostra grinnelli Griscom

Loxia curvirostra benti Griscom

Red Crossbill

5 mi. E and 3 mi. S Cima, May 25 (1 *grinnelli*); Cedar Canyon, May 21-31 (2 *benti*); 5 mi. NE Granite Well, Dec. 28–Jan. 2 (6 *benti*). Total specimens, 9.

Crossbills were found in the Mid Hills section of the Providence Mountains in midwinter and again in late May, 1938. At both seasons most of them were in compact flocks numbering from 4 to 20 individuals, which circled about overhead, calling, or foraged silently in piñons. We saw them in no other trees, except once briefly in junipers. The crops and gullets of birds shot contained chunks of shelled piñon seeds at both seasons, and a female shot May 25 had shelled and eaten smaller seeds in addition.

A flock of nine adult crossbills, not including any streaked young, was seen at Cedar Canyon on May 25, 1938. They perched in trees on the sides of a shallow ravine near where a trickle of water seeped from a crack in a granite ledge and formed a tiny pool in a depression. A male flew down and drank at the pool. This bird and a female were shot, and they proved not to be in breeding condition. The testes of the male were about 2 mm. long; the female was extremely fat and had only small ova. Both birds were beginning to molt, as shown by replacement of the innermost primaries. On the same day, at about two miles farther north (5 miles east and 3 miles south of Cima) a solitary juvenal female crossbill, just beginning to molt into the postjuvenal plumage, was shot from a dead piñon stump.

The last-mentioned young bird (no. 74428) has a very large bill (exposed culmen 18.3 mm., depth at base 9.8 mm.), in this respect resembling juvenal specimens in the Museum of Vertebrate Zoölogy from northwestern Arizona that were referred by Griscom (1937:133 and 147) to the race *grinnelli*. The other eight specimens from the Providence Mountains, all adults, have appreciably narrower bills, and on the basis of size and the color of the males, both in winter and in summer, are referred to the Rocky Mountain race *benti*.

If the above identifications are correct, the crossbill situation in the Providence Mountains area between December, 1937, and the end of May, 1938, must have been as follows: (1) a population of *grinnelli* bred within the area or near enough to be within the wandering radius of a juvenal bird, as for example, the Grapevine Mountains, Nye County, Nevada (Miller, 1946:56, 59); (2) a conspicuous population of *benti* present in midwinter and in May, and which, in the interval between, either (a) bred within the area with the young dispersing quickly, (b) went elsewhere to breed and the same or other birds returned, or (c) remained in the area and began the annual molt without

breeding. Considering the well-known eccentricities of the species, any of the above alternatives seem possible. No crossbills were found on Clark Mountain in May, 1939.

Chlorura chlorura (Audubon)
Green-tailed Towhee

N side Clark Mt., 5,400 ft., May 24*; SE side Clark Mt., 6,300 ft., May 19*; S side Clark Mt., 5,000 ft., May 21*; Mescal Cave, May 18*, May 30; Cedar Canyon, May 21-31*. Total specimens, 7. Stephens (1903:103) saw a green-tailed towhee at 6,000 feet altitude in the Providence Mountains in 1902.

Green-tailed towhees were found only in May at elevations between 5,000 and 6,300 feet, and then they were not abundant. Those seen were in or near thickets of dense bushes, and this habitat was poorly developed throughout most of the area. Near Mescal Cave green-tailed towhees inhabited the bottoms and sides of ravines, where bushes and small piñons and junipers were intermixed. At Cedar Canyon one was seen in a bush of desert thorn (*Lycium*).

The species may breed in small numbers. Two birds, evidently paired, were seen together on Clark Mountain on May 19, 1939, and females taken then and on May 24 had slightly enlarged ova. A male taken at Cedar Canyon on May 24, 1938, had testes 5 mm. long.

Pipilo maculatus montanus Swarth
Spotted Towhee

N side Clark Mt., 5,400 ft., May 23-28; NW side Clark Mt., 7,300 ft., May 20*; SE side Clark Mt., 5,500-6,300 ft., May 18-23*; Cedar Canyon, Jan. 5-8, May 25–June 2*; 1 mi. S. Rock Spring, June 6*; 5 mi. NE Granite Well, Dec. 28–Jan. 5*. Total specimens, 17.

These towhees were present in winter and in summer in brushy places above 4,800 feet altitude. They were more abundant and more widely distributed in summer than were green-tailed towhees. There was no appreciable difference between summer and winter habitats of spotted towhees, but in brush patches along the north side of the wash at Cedar Canyon they were relatively abundant in January, 1938, but were absent the following May.

The habitat sought out by spotted towhees consisted of large dense, stiff-branched shrubs, where these grew in protected situations, as at the bases of cliffs or rocky hills and in the bottoms of narrow ravines. Another feature that seemed to be an essential part of the habitat was the presence of trees, such as piñons or junipers, from which the males sang for prolonged periods in the breeding season. For example, a pair seen near Rock Spring on June 6, 1938, was in a large catclaw bush that spread partly over a boulder at the base of a piñon-covered slope. They were fairly common in the fir forest on Clark Mountain in 1939.

In the winter spotted towhees were solitary or in small groups. At five miles northeast of Granite Well, a group of four individuals was seen on December 29, 1937. They were all intensely colored, hence were thought to be males. None of this group was shot, but all the six winter-taken specimens, which came from this same locality, proved to be males. In May, they were definitely paired, and the males were singing loudly from prominent perches. Males

taken on May 17 and 23, 1939, had testes of maximum size, about 12 mm. long. Females taken on dates ranging from May 18 to June 6 contained enlarged ova. One of the latter, shot on May 23, 1939, on Clark Mountain had an old brood patch and was about to start laying again.

All our specimens are here referred to the race *montanus*, the metropolis of which lies to the eastward in Arizona, because in length of tail and extent of white on the outer tail feathers they agree more closely with that race than with any other currently recognized, although in length of wing our winter-taken specimens more closely resemble *curtatus* of northern Nevada.

Measurements of the Providence Mountains birds are of interest as compared with average measurements published by Swarth (1905:173) of *montanus* from southern Arizona and New Mexico and (1913:175) of *curtatus* from Nevada and Oregon. In males, the average tail length of four May-taken specimens is 102.2 mm. and of six midwinter specimens is 104.5 mm., compared with 106.5 mm. for seventeen *montanus* and 98 mm. for six *curtatus;* the average length of the white area on the inner web of the outermost rectrix in five May specimens is 29.1 mm. and in six midwinter specimens is 32.0 mm., compared with 31.2 mm. in *montanus* and 27.5 mm. in *curtatus;* the average wing length is 90.1 mm. in six May specimens and 86.3 mm. in six midwinter specimens, compared with 92.2 mm. in *montanus* and 85.7 mm. in *curtatus.* The chance of the short-winged winter birds being migrants of *curtatus* is discounted because their tails are definitely of the *montanus* type.

Amphispiza bilineata deserticola Ridgway
Black-throated Sparrow

8 mi. W Clark Mt., May 28; N side Clark Mt., 5,500 ft., May 24-26*; Pachalka Spring, May 31, Oct. 2; S and SE sides Clark Mt., 5,000-6,300 ft., May 16-22*; Mountain Pass, Oct. 4; Valley Wells, June 1; Mescal Spring, May 23, May 30; Mescal Cave, May 18, May 30; 3 mi. N Ivanpah, April 25*; 5 mi. SW Ivanpah, May 15; 1 mi. N Barnwell, May 30; Purdy, April 26-27; 3 mi. N Cima, May 14; 2 mi. NNE Cima, May 12-19*; Cedar Canyon, Jan. 7-8, May 20–June 3*; Government Holes, May 27*; Rock Spring, May 27; 2 mi. ESE Rock Spring, June 4-6*; 5 mi. NE Granite Well, Dec. 30*; 3 mi. S Granite Well, Dec. 20-21*; 5 mi. S Granite Well, Dec. 18*; 6 mi. S Granite Well, Dec. 20*; Kelso, June 21; 2½ mi. SW Kelso, June 18-19; Mitchell's, June 8-10*, Dec. 24-26*; Colton Well, June 7*; Snake Spring, June 23-24. Total specimens, 19. Reported by Stephens (1903:103) as "rather common at base of Providence Mountains" in 1902, and by Hollister (1908:460) as "fairly common . . . in Ivanpah Valley" in early June, 1905.

Black-throated sparrows were probably seen more frequently than any other birds in the area, and we gained the impression (partly supported by local censuses) that this was the commonest avian species. Individuals were noted specifically in a great variety of situations, of which the following are most representative: open brushland; rocky brush-covered slope; brush along base of rimrock; cholla cactus; mixed grass and brush; on small hill with sparse creosote bushes and other shrubs. Males occasionally sang from Joshua trees.

The breeding range covered all the Lower Sonoran Zone where there were bushes, including creosote bush flats and alluvial fans, the Joshua trees, and washes fringed with catclaw and desert willow. The highest elevation recorded was 6,300 feet, on Clark Mountain. In the mountains, black-throated sparrows

were restricted to areas of open brushland and were found in such Upper Sonoran shrubs as sagebrush and *Purshia*. The upper boundary of their local range usually corresponded closely with that of the Joshua trees. These sparrows appeared to be fewer in winter, and it seems likely that part of the population had migrated outside the area.

At that season they were frequently in mixed flocks with Brewer sparrows, and tended to stay more in canyons and about the bases of rimrock cliffs. A flock of eight watched near Mitchell's on December 26, 1937, was foraging in the rain. They were very active, hopping about and apparently picking up seeds from the bare ground beneath bushes.

FIG. 45. Black-throated sparrow on nest in cholla cactus at Cedar Canyon. Photograph taken May 22, 1938.

In April and May, they were definitely paired and appeared to be defending territories. At Purdy on April 26, 1920, it was estimated that there was a pair of black-throated sparrows in each five acres. One member of a pair, closely attended by the other, was carrying nest material.

We found the following nests of black-throated sparrows: North side of Clark Mountain, nest about one-third built on May 25, 1939. Southeast side of Clark Mountain, nest with 4 eggs on May 20, 1939; another with 4 eggs on May 24. Two miles north-northeast of Cima, nest with 3 young half-grown on May 13, 1938; nest with 4 old, long-abandoned eggs and 4 fresher, recently abandoned eggs on May 14; nest being built on May 13, with 2 eggs on May 19; nest with one egg on May 17, 3 eggs on May 19. Cedar Canyon, nest with 4 eggs on May 20 and May 24. Two miles east-southeast of Rock Spring, nest with two eggs partly incubated on June 6, 1938. The nest at Cedar Canyon (fig. 45) was near the center of a small, dense cholla cactus that grew among bushes in a side wash. A parent, assumed to be the female, stayed closely on the nest and, when frightened away by too near an approach, soon returned in spite of the observer's presence. The needle-sharp thorns of the cactus surrounded the

nest so closely that the parent seemed to have difficulty in avoiding them. Each time it approached or left, the bird paused to snip off the tips of some of the thorns. When disturbed only enough to cause it to stand on the edge of the nest, it had difficulty in turning around to sit on the eggs again. The nest near Rock Spring, which was in a *Purshia* bush, had a diameter of about 110 mm.; height to rim about 60 mm.; nest cavity 50 mm. in diameter and 40 mm. deep. The outer framework was principally of stiff, dry bundles of dead Joshua tree leaf fibers, with a few grass and weed stems woven in. The lining was of softer material, including individual Joshua tree leaf fibers, cow hairs, and seeds of composites. The last were apparently selected because of the soft, plumelike pappus.

The nests were seldom more than two feet above the ground, and thus were within the reach of most ground-dwelling predators. Near Cima on May 13, 1938, a red racer (*Coluber flagellum*) was found just after it had swallowed three half-grown young from a nest in a low bush.

Amphispiza belli nevadensis (Ridgway)
Bell Sparrow

Murphy Well, Jan. 10; 3 mi. N Cima, Jan. 9-12; 2 mi. NNE Cima, May 13; Cedar Canyon, Jan. 1-8; 5 mi. NE Granite Well, Dec. 28–Jan. 2*; 3 mi. S Granite Well, Dec. 20-21*; 6 mi. S Granite Well, Dec. 22-24; Mitchell's, Dec. 24; 7 mi. NW Essex, Dec. 22*. Total specimens, 9.

Small flocks of Bell sparrows frequented brushy areas at elevations up to 5,400 feet in the winter. A single individual was reported seen by Arvey near Cima on May 13, 1938; we have no other spring or summer records for Bell sparrows, although special search was made for them in an apparently suitable breeding habitat near Government Holes.

Flocks of from 5 to 10 individuals, sometimes mixed with larger numbers of Brewer sparrows, foraged on the ground and in low bushes in a small valley three miles south of Granite Well on December 20 and 21, 1937. The presence there of clumps of bunch grass interspersed among low bushes apparently made this particular place more attractive for Bell sparrows than any other place in the area. Smaller and more scattered flocks were also found in creosote bush association northwest of Essex and in sagebrush near the head of Cedar Canyon.

Junco hyemalis hyemalis (Linnaeus)
Junco hyemalis cismontanus Dwight
Slate-colored Junco

Cedar Canyon, Jan. 5 (1 *cismontanus*); 5 mi. NE Granite Well, Dec. 29 (1 *hyemalis*); Mitchell's, Dec. 25 (1 *cismontanus*). Total specimens, 3.

Slate-colored juncos were taken in the winter, each at a different locality, from flocks of the more abundant Oregon juncos. The one identified as subspecies *hyemalis* was a female taken in piñon-juniper association in the hilly country northeast of Granite Well. Both birds identified as *cismontanus* were males; one was in the dense piñons north of Cedar Canyon; the other came to drink at a pool in the narrow, rocky canyon above Mitchell's.

Junco oreganus montanus Ridgway
Junco oreganus oreganus (Townsend)
Junco oreganus shufeldti Coale
Oregon Junco

Cedar Canyon, Jan. 5-8 (6 *montanus*, 2 *oreganus*, 1 *shufeldti*); 5 mi. NE Granite Well, Dec. 27–Jan. 5 (12 *montanus*, 1 *shufeldti*); Mitchell's, Dec. 25-26 (4 *montanus*, 1 *shufeldti*). Total specimens, 27. Stephens (1903:102) records "*Junco oreganus thurberi*" as "rare" in the Providence Mountains in late May or early June, 1902.

Flocks of wintering Oregon juncos were common in the piñon belt in December and January. They foraged on the ground and through low bushes and when not foraging kept to the tops of piñon and juniper trees. The largest flock noted, five miles northeast of Granite Well on January 5, 1938, included about 50 juncos. The average number in a flock was about 10. Frequently other birds followed along with the junco flocks, and again, a few juncos might be found in flocks predominantly of other species. This kind of association was noted in varying degree between Oregon juncos and slate-colored juncos, white-crowned sparrows, bush-tits, titmice, spotted towhees, verdins, and ruby-crowned kinglets.

It is apparent that the midwinter population of Oregon juncos in the area was made up chiefly of birds that bred directly northward, in the northern Rocky Mountain region (subspecies *montanus*), together with smaller numbers that bred farther west toward the coast (subspecies *shufeldti*) and farther north in Alaska or western Canada (subspecies *oreganus*).

Junco caniceps caniceps (Woodhouse)
Gray-headed Junco

The breeding of gray-headed juncos in the Transition Zone on Clark Mountain has been reported by Miller (1940:163). A singing male with enlarged testes was taken from the top of a dead fir on May 20, 1939, and on May 24 another male was singing in the same general vicinity. This small area on the northwest side of Clark Mountain appeared to be the only suitable breeding place for juncos of any kind. On May 25, 1938, a junco was seen (by Aldrich) in mixed sagebrush and piñon association in the hills north of Cedar Canyon. It was perched in a clump of ephedra and old cactus stems and was giving a submaximal song. This bird was probably a straggler or a late migrant not yet on its breeding grounds.

The one specimen available from the area resembles those from the Charleston Mountains in having some pinkish color on the sides, which is interpreted (Miller, 1941:191) as the result of hybridization between *caniceps* and *Junco oreganus thurberi*.

Spizella passerina arizonae Coues
Chipping Sparrow

SE side Clark Mt., 6,300 ft., May 19*; Mescal Cave, May 18*. Total specimens, 2.

The two chipping sparrows that were taken were evidently late spring mi-

grants. The ovaries of a female shot on May 19, 1939, on Clark Mountain were not enlarged. Both birds were in canyon bottoms near the lower edge of the piñon belt.

Spizella breweri breweri Cassin

Brewer Sparrow

3 mi. N Cima, May 14, Jan. 10; 2 mi. NNE Cima, May 13-19*; Purdy, April 26; Cedar Canyon, Jan. 7, May 20–June 3*; Government Holes, May 27; 5 mi. NE Granite Well, Jan. 2; 3 mi. S Granite Well, Dec. 20-21*; 6 mi. S Granite Well, Dec. 20; Mitchell's, Dec. 26. Total specimens, 10. Hollister (1908:460) saw a "few" Brewer sparrows in Ivanpah Valley and collected one there on June 2, 1905.

In the winter, flocks of Brewer sparrows foraged over the alluvial fans and along the bases of the mountains, and in the summer pairs nested, generally at higher elevations, in unforested, brushy places.

Fig. 46. Brewer sparrow on nest in sagebrush 2 miles north of Cedar Canyon, 5,500 feet. Photograph taken May 28, 1938.

Flocks containing 10 to 20 Brewer sparrows and a smaller number of sage sparrows foraged in an area of mixed bunch grass and low shrubs, three miles south of Granite Well, on December 20 and 21, 1937. On April 26, 1920, roving flocks of Brewer sparrows, apparently in migration, were seen in Joshua tree association at Purdy. Nesting was well under way near Cima when we arrived there in mid-May, 1938. Remarkably enough, no Brewer sparrows were found on Clark Mountain in 1939, although they were abundant in that season in the Kingston Range, just northwest of the Providence Mountains area.

Two miles north-northeast of Cima a Brewer sparrow's nest was built 12 inches above the ground in the center of a 30-inch high ephedra bush. This nest and two others found in the same vicinity were made almost entirely of dry leaves and stems of grass, with a few coarse weed stems in the outer framework and fine cow hairs in the lining. One nest contained three eggs on May 14, 1938, and two others contained 2 and 4, respectively, on May 18. Young birds were out of the nest at that locality as early as May 13. At Cedar Canyon on

May 31 a nest with 4 eggs was found 14 inches up in a desert thorn (*Lycium cooperi*) bush. Another nest found on May 28 in the hills two miles north of Cedar Canyon was 27 inches from the ground in a dense clump of sagebrush and about 20 yards from a similarly situated black-chinned sparrow nest. A parent was incubating four eggs (fig. 46).

Spizella atrogularis evura Coues
Black-chinned Sparrow

N side Clark Mt., 5,000-5,400 ft., May 23-25*; SE side Clark Mt., 5,800-7,500 ft., May 16-21*; Mescal Cave, May 30; Cedar Canyon and vicinity, 5,000-6,400 ft., May 24–June 2*; Mitchell's, June 9-10*. Total specimens, 34. Stephens (1903:103) gives an account of a black-chinned sparrow seen by him in 1902: "Saw a female carrying a larva of some kind in her bill, on Providence Mountains, about June first. She came quite close to me and acted as if her family were near." In 1905, Hollister (1908:460) found them "fairly common on New York Mountain. Full fledged young were taken June 7."

FIG. 47. Nesting habitat of black-chinned sparrow 2 miles north of Cedar Canyon. Nest was situated in sagebrush near a juniper. Photograph taken May 28, 1938.

Black-chinned sparrows were summer residents throughout the Upper Sonoran Zone, at elevations between 5,000 and 7,500 feet. They stayed in brush-covered areas for the most part, nesting in sagebrush and foraging through piñons, junipers, and a variety of shrubs, including coffee berry, sagebrush, and ephedra. A few were seen in brush patches in the bottoms of rocky canyons and on ridges, but the greatest numbers were in situations such as that shown in figure 47, where stands of tall and fairly dense sagebrush grew in isolated shallow basins among rocky, piñon-covered hills. On May 29, 1938, it was estimated that there was a breeding population of four pairs to a square mile where conditions were favorable near Cedar Canyon.

In the spring of 1938, black-chinned sparrows first appeared near the floor of Cedar Canyon on May 24 and increased in abundance until June 2. On May 31 it was noted that the volume of song was increasing rapidly, either because more birds were singing or because individual birds were singing more.

At this time nesting was more advanced higher in the hills north of the canyon. For example, a nest with three eggs was found on May 28 at 5,500 feet. It was wholly concealed from view in the center of one of many dense clumps of sagebrush that grew near the bed of a small wash. The nest (fig. 48) was

FIG. 48. Nest and eggs of black-chinned sparrow in sagebrush in area shown in figure 47. Photograph taken May 28, 1938.

26 inches from the ground in a bush 40 inches high. The outside diameter and depth were each 4 inches, the inside diameter and depth each 1⅞ inches. The framework consisted chiefly of closely woven dry fibers from leaves of *Yucca baccata;* the lining was of brown and white cow hairs. Females collected near there on that day had already laid eggs or contained small ova; males had testes about 4 mm. long.

A female black-chinned sparrow was shot in a coffee berry bush at Mitchell's on June 9, 1938. Its beak was full of insects, evidently for nestling birds.

On Clark Mountain in 1939, pairs were seen as early as May 16. Nesting seemed to be well under way then; all the females taken had brood patches.

Zonotrichia leucophrys oriantha Oberholser
Zonotrichia leucophrys gambelii (Nuttall)
White-crowned Sparrow

Pachalka Spring, Oct. 2 (1 *gambelii*); S side Clark Mt., 5,000 ft., May 21 (1 *oriantha*); Cedar Canyon, Jan. 5-8; 5 mi. NE Granite Well, Dec. 27–Jan. 4 (3 *gambelii*).

In October, December, and January, white-crowned sparrows in flocks

numbering up to 60 or more individuals were a conspicuous part of the avifauna at Pachalka Spring and in the Mid Hills section. All the records are from elevations of 4,800 feet or higher.

The winter flocks foraged over the sandy flats among sagebrush and piñons. They were most abundant where convenient refuge places were provided by stiff-branched shrubs such as grew at the bases of rock ledges and along the walls of Cedar Canyon. A flock was nearly always to be found about the buildings at Stott's.

Careful scrutiny of the birds making up the winter flocks failed to reveal the presence of any white-crowned sparrows of other than the "*gambelii*" type.

Two birds seen on May 21, 1939, on the south side of Clark Mountain were evidently late migrants. The one that was taken, a female, was of the race *Z. l. oriantha.*

Passerella iliaca schistacea Baird

Fox Sparrow

A migrant fox sparrow was taken at the entrance to Mescal Cave on October 4, 1945. It is a typical representative of the race breeding in the Rocky Mountains and northern and eastern Great Basin.

Melospiza melodia merrilli Brewster

Song Sparrow

A migrant song sparrow of this northern race was taken at Pachalka Spring on October 2, 1945.

MAMMALS

Family Vespertilionidae

Myotis thysanodes thysanodes Miller

Fringed-tailed Myotis

An adult bat of this species was taken shortly after dark on the evening of June 8, 1938, in a short, rock-walled mine tunnel at Mitchell's. It flew back and forth a few times, until it was knocked down with a hat.

Myotis volans interior Miller

Hairy-winged Myotis

Three specimens of *Myotis volans* were taken at widely separated localities. The first was a young adult female, without embryos or any indication of having had young recently, that was hanging from the rocky ceiling of a mine tunnel five miles southwest of Ivanpah on May 15, 1938. The bat was sluggish and cool to the touch. The air in the tunnel was moderately cool and that outside was uncomfortably warm. The second specimen was shot at dusk in Cedar Canyon on May 24, 1938. It was flying about 20 feet above the ground. The third was a female that was caught on the evening of June 23, 1940, when it dipped down to drink from the water trough at Snake Spring.

Myotis californicus stephensi Dalquest
California Myotis

Pachalka Spring, May 31*, Oct. 2*; Cedar Canyon, May 21*; Snake Spring, June 23-24*; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 11.

About 12 small bats were flushed from a crack, averaging ½ inch wide, beneath an exfoliating slab of granite 30 feet from the top of the east face of the rocky pinnacle at the mouth of Cedar Canyon in broad daylight on May 21, 1938 (figs. 31 and 49). Two were captured by hand and proved to be fully grown females of this species. The remainder dispersed and flew into larger cracks nearby.

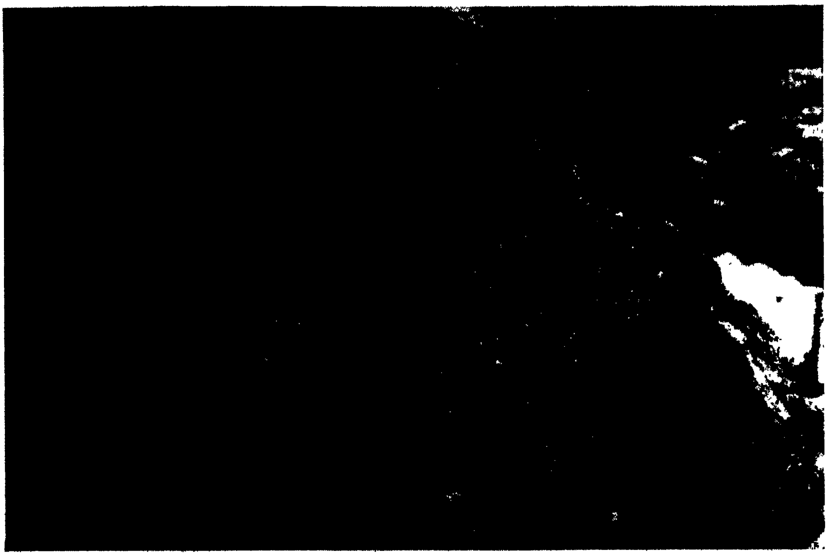


FIG. 49. Crack in granite at pinnacle at mouth of Cedar Canyon (fig. 31) inhabited by California myotis. Photograph taken May 22, 1938.

On the evening of June 23, 1940, five of 29 bats that were captured at a water trough at Snake Spring were of this species. They appeared at about 7:30 p.m., nearly an hour after the first pipistrelles were seen. Specimens from Pachalka Spring and from the pass between the Granite Mountains and the Providence Mountains were taken in flight at dusk.

All ten specimens collected in the area in spring were females. None contained embryos, but one taken on June 23, 1940, showed evidence of having nursed young recently. A male was taken on October 2.

In color, the Providence Mountains specimens closely resemble others in the Museum of Vertebrate Zoölogy from localities in the desert ranges of east-central California, southern Nevada, and northwestern Arizona. All these specimens are slightly darker, nearer Ochraceous Buff, than the Light Ochraceous Buff topotypes of the race *stephensi* from Vallecito, San Diego County, California, which in turn are slightly darker than specimens from Sierra del Pinacate in northwestern Sonora, where the pale color of *stephensi* seems to be

most fully developed. The Providence Mountains series thus shows affinities with the population of the southern Great Basin rather than with that of the Sonoran Desert and shows an approach toward the darker subspecies *californicus*. For use of the name *stephensi*, see Dalquest (1946:67).

Myotis subulatus melanorhinus (Merriam)
Small-footed Myotis

Pachalka Spring, May 31*, Oct. 2*; Mescal Spring, May 29*; Mitchell's, Dec. 26*. Total specimens, 12.

The four individuals of this species that were taken in late May, 1940, were shot in flight at dusk at Pachalka Spring and at Mescal Spring. At each of these places there was a small area of open water and a few trees. Seven were taken in October at Pachalka Spring by means of wire strung over the water and by a hand net.

The single specimen from Mitchell's is a male that was found on the morning of December 26, 1937, hanging in a semitorpid condition from the rocky ceiling of a tunnel that had been dug in a canyon bottom to increase the flow of a small natural spring.

The specimens, all but two of which are males, show wide variation in color, ranging from near Warm-Buff to near Buckthorn Brown. Nevertheless this variation may be regarded as individual and seasonal rather than racial. The palest specimen is the one taken in winter.

Pipistrellus hesperus hesperus (H. Allen)
Western Pipistrelle

Pachalka Spring, May 31*, Oct. 2*; SE side Clark Mt., 6,300 ft., May 17*; Mescal Spring, May 29; Cedar Canyon, May 24–June 3*; Colton Well, June 7-8*, Oct. 6*; 2½ mi. SW Kelso, June 21*; Snake Spring, June 23-24*. Total specimens, 52.

Pipistrelles were more abundant than bats of any other species. They usually appeared early in the evening and often were the only bats seen. Our records show an altitudinal range from 2,100 to 6,300 feet, broader than that of any other species of bat in the area. Apparently they spent the daytime in crevices among rocks in the lower, rugged parts of the mountains and emerged at dusk to forage widely over the washes and alluvial fans. At Cedar Canyon on the evening of May 27, 1938, several were seen flying down one of the narrow side canyons at 6:43 p.m., shortly after sundown. They were flying higher above the ground, faster, and in a more direct course than is usual with foraging pipistrelles. When it was nearly dark on the evening of June 21, 1940, a pipistrelle appeared in the sandy area southwest of Kelso, several miles from any cliffs or rocky canyons that would serve for daytime retreats. This bat flew back and forth in a beat about 50 yards long on the south side of a wash, paralleling the upper edge of a dirt bank about 12 feet high. It seemed to prefer this particular strip of territory to any other in the vicinity. It did not go near the clumps of desert willows in the wash, nor did it forage over the adjacent creosote bush flats.

Large numbers of pipistrelles congregated to drink at an open-topped,

water trough at Snake Spring. On the evening of June 23, 1940, they first appeared in broad daylight at about 6:30 p.m. and were still coming long after dark. Of 37 bats captured, 29 were pipistrelles, as were 14 of the 15 bats caught there the following evening. There was evidently a period of feeding before the bats came to drink, because each individual caught at the water trough had its stomach distended with insect remains. All but two of the 43 pipistrelles taken there were females, and one of the two males was abnormal. This individual (no. 92507, in alcohol) had been injured some time previously, judging from the completely healed scars. All its injuries were on the left side; the eye and ear were completely missing, the jaw articulation displaced so that the mouth could not be opened as far as normally, the right forearm broken near its middle and healed at an angle of 50 degrees, and the distal edge of the wing membrane tattered and incomplete.

Females containing embryos were taken as follows: In 1938, on May 27 and June 3 at Cedar Canyon, and on June 8 at Colton Well; in 1939, on May 31 at Pachalka Spring. There are four records of two embryos and one of a single embryo. None of the 41 females taken at Snake Spring on June 23 and 24, 1940, had embryos, but most of them had nursed young recently. We found no young pipistrelles.

Eptesicus fuscus pallidus Young
Big Brown Bat

Pachalka Spring, Oct. 2*; Cedar Canyon, May 24*; Snake Spring, June 23*. Total specimens, 6.

A male shot at Cedar Canyon on May 24, 1938, was flying down a narrow side canyon at 7:15 p.m. Four females were caught and at least two other bats of this species were seen over the water trough at Snake Spring on June 23, 1940. They first appeared at 8:30 p.m., when it was completely dark. Each of the four females appeared to have nursed young earlier in the season, but none contained embryos and no young-of-the-year were found.

Lasiurus cinereus cinereus (Peale and Beauvois)
Hoary Bat

A female hoary bat, shot on the evening of May 17, 1939, at 6,300 feet altitude on the southeast side of Clark Mountain, contained two embryos, each 17 mm. long and apparently almost ready for birth.

Corynorhinus rafinesquii pallescens Miller
Long-eared Bat

5 mi. SW Ivanpah, May 15*; Mitchell's, June 10*. Total specimens, 3.

The five individuals of this species that we saw were all hanging from the rocky ceilings of mine tunnels, about at the point where daylight from the entrance was barely visible. Each bat was solitary, although two were found in different places in one tunnel at Mitchell's, and a *Myotis volans* was in the same tunnel with a long-eared bat 5 miles southwest of Ivanpah. Three of the five were semitorpid and allowed themselves to be caught by hand; the re-

maining two flew away and escaped when the rays of a flashlight struck them.

We were told that bats, all thought to be of this species, were abundant in the limestone caves at Mitchell's in the summer.

Antrozous pallidus pallidus (LeConte)
Pallid Bat

Pallid bats flew about desert willow clumps in a wash in the marginal sand dune area 2½ miles southwest of Kelso on evenings in June, 1940. On June 20 the first bat appeared late in the evening, while there was yet a little daylight. It was shot and proved to be an adult female without embryos. Its bare and enlarged nipples indicated that it had recently nursed young. This bat and others seen shortly afterward flew up the wash from the west, where they may have found roosting places in the buildings at Flynn. None went farther than the last clump of desert willows. They flew about in broad circles, as high as 30 feet above the ground and sometimes swooped down close to the sandy bed of the wash.

All the large bats seen early in the evening, including the one that was shot, were silent; but later, at about 10 p.m., bats of similar size and manner of flight flew by, constantly giving a sharp metallic clicking sound.

Family Procyonidae

Bassariscus astutus (Lichtenstein)
Ring-tailed Cat

Although we obtained no specimens of ring-tailed cats in the Providence Mountains area, the following information obtained from residents indicates that the species is present there.

Mr. A. H. Thomas told us in December, 1937, that one had been caught in the general vicinity of his place (5 miles southeast of Cima) within the last year. On May 15, 1938, two miners living in a canyon five miles southwest of Ivanpah said a ring-tailed cat had been trapped there in the previous winter. Mr. J. Mitchell told us on June 25, 1940, that one had been killed at his place a short time before. All these localities are at about 4,500 feet altitude, in the rocky terrain near the bases of the mountains and near the lower edge of the piñon belt.

Family Mustelidae

Spilogale gracilis gracilis Merriam
Spotted Skunk

Spotted skunks were widely distributed, but apparently nowhere common, at middle elevations. Several residents reported having seen or trapped them, but none knew of striped skunks (*Mephitis*) in the area. All the reports came from the rough terrain in the lower parts of the mountains and at the heads of the alluvial fans.

A young adult female spotted skunk was found near midday on January 2, 1938, at the inner end of an abandoned mine tunnel five miles northeast of

Granite Well. It was on the floor of the tunnel, in complete darkness, among the litter of sticks and cactus spines that had been carried in by woodrats. Mr. Bert Smith reported in May, 1938, that a spotted skunk had come around his cabin at Rock Spring.

The one specimen (no. 79862 ♀) has been compared with specimens of the races *gracilis*, *saxatilis*, *arizonae*, *microrhina*, and *martirensis*. On the basis of its small size (total length 354 mm., tail 129 mm., hind foot 38 mm., weight 203 grams) and reduced amount of white, especially on the posterior part of its body, it agrees most closely with *gracilis*. The skull differs from skulls of each of the aforementioned races in its small size, short and narrow rostrum, flattened brain case, depressed occiput, and recessed bullae, but most closely approaches a specimen of *gracilis* from Junction Ranch, Inyo County, California, and others, assigned to *saxatilis*, from various localities in central Nevada. The second upper molar on each side is missing.

Taxidea taxus berlandieri Baird
Badger

Pachalka Spring, Oct. 2 (fresh burrow); S side Clark Mt., May 21 (fresh burrows); vicinity of Cima, Dec.–Jan.*; Cedar Canyon, May 23*; 2 mi. ESE Rock Spring, June 5*; 6 mi. S Granite Well, Dec. 20 (burrow); 2½ mi. SW Kelso, June 20-22*. Total specimens, 7.

FIG. 50. Adult female badger in trap at Cedar Canyon. Photograph taken May 23, 1938.

Badgers ranged widely over the area and apparently penetrated every type of habitat except cliffs and the rockiest canyons. Trappers considered them rather rare in comparison with coyotes, gray foxes, and bobcats.

The habitats in which individual badgers were actually seen include: shallow wash among granite ledges in heavy piñons (Cedar Canyon); abandoned field in Joshua tree–purshia association (near Rock Spring); among Joshua trees on alluvial fan (near Cima); sandy bluff at edge of wash in desert wash habitat (near Kelso).

A steel trap baited with the body of a jack rabbit at Cedar Canyon held an adult female badger when it was visited on the afternoon of May 23, 1938. A young male measuring 575 mm. in total length (as compared with 640 and 685 mm. for two adult males from the area) was lying under a bush nearby, apparently reluctant to leave its mother. This female (fig. 50), a fairly old individual judging from tooth wear, had obviously nursed young recently, but a younger female estimated to be about one year old that was taken near Rock Spring on June 5 of the same year had apparently never nursed young.

Six badger holes had been dug into the base of a sandy bluff about 50 yards long at the edge of a wash southwest of Kelso. Fresh badger tracks were seen there on June 20, 1940, and on June 22 an adult male badger was trapped at the entrance of one of the holes.

The specimens taken are uniformly small; the average total length is 663 mm. for two males, 621 for two females; the average condylobasal length of skull is 117.1 mm. for three males, 112.1 mm. for two females. Five skins are available from the area. The median dorsal white stripe extends in two (mother and son from Cedar Canyon) to the base of the tail, in one to the rump, in one to the middle of the back, and in one only to the shoulders.

Family Canidae

Vulpes macrotis arsipus Elliot
Kit Fox

8 mi. W Clark Mt., May 28 (tracks); vicinity of Cima, Jan. 12*; 2 mi. SW Colton Well, Dec. 26; 2½ mi. SW Kelso, June 19-23*. Total specimens, 2. Grinnell, Dixon, and Linsdale (1937, vol. 2:402) record 3 specimens from Ivanpah in the U. S. National Museum.

Kit foxes were regularly distributed and in some places relatively abundant in the lower, unforested parts of the area. The lower reaches of the alluvial fans, where creosote bushes predominate and the soil is mainly fine sand, provided the most suitable habitat, but the record from near Cima indicates that they occurred also in the Joshua tree belt.

In the area southwest of Kelso, kit fox tracks and feces were abundant in the basins and washes among the sand dunes in June, 1940. A female was trapped in the center of a broad wash bordered with creosote bushes and desert willows on June 23. A resident of Kelso told us that in 1925 he trapped about 100 kit foxes in that vicinity.

A kit fox caught in one of our traps 2 miles southwest of Colton Well on December 26, 1937, was killed and eaten in the trap by a golden eagle.

Urocyon cinereoargenteus scottii Mearns
Gray Fox

N side Clark Mt., May 24 (sign); SE side Clark Mt., May 18-23*; vicinity of Cima, Dec.–Jan.*; 5 mi. SE Cima, Dec. 20–Jan. 3*; Cedar Canyon, Jan. 6-8*; 5 mi. NE Granite Well, Jan. 5 (sign); 6 mi. S Granite Well, Dec. 22-24; Mitchell's, Dec. 24. Total specimens, 12.

Gray foxes occurred in the area only in broken terrain where there were piñons or occasional thickets of brush. Along the outlying spurs of the mountains they entered the Joshua tree belt, but they were not found by us or

TABLE 6

AVERAGE AND EXTREME MEASUREMENTS (IN MILLIMETERS) OF

Urocyon cinereoargenteus scottii

FROM THE PROVIDENCE MOUNTAINS AREA AND ADJACENT VALLEY OF COLORADO RIVER

Sex	Area	Number of specimens	Total length	Length of tail	Length of hind foot	Number of specimens	Condylobasal length of skull	Zygomatic breadth	Depth of brain case (including bullae)
Males	Providence Mts.	3	962	400	137	5	120.8	65.2	44.8
			910–1006	365–421	130–143		118.2–126.1	62.8–66.7	43.9–46.9
	Colorado River	7	970	415	133	9	117.9	63.7	44.0
			935–1030	390–435	125–140		116.0–122.6	62.4–64.8	42.2–45.8
Females	Providence Mts.	4	958	400	130	6	116.2	63.3	42.9
			900–1000	367–417	125–135		112.5–117.0	60.9–67.9	41.5–44.8
	Colorado River	3	937	410	131	3	114.7	63.1	43.7
			930–950	405–420	130–132		112.1–118.1	61.4–64.8	43.5–44.0

reported by trappers from the sandy flats. Thus their local range was complementary to that of kit foxes. The lowest elevation at which gray foxes were found was 3,800 feet, 6 miles south of Granite Well, where one was seen among large boulders at the base of a hill. Evidence of their presence was found nearly to the summit of Clark Mountain.

Because their metropolis was in the rough country where roads were few, gray foxes were caught less frequently than kit foxes and coyotes by the itinerant trappers who ran trap lines for many miles by automobile along roads in the valleys and on the alluvial fans. Local, small-scale trapping of gray foxes was carried on by resident miners and cattlemen in the winter months. In the winter of 1937-1938 these people were trapping mostly as a pastime, because fur prices were admittedly too low to make the enterprise profitable.

Four gray foxes, 3 females and one male, were trapped within 48 hours in a small ravine in the piñons north of Cedar Canyon, January 6-8, 1938, by a member of our party (Taber), using prepared animal scent as bait. One female was caught at midafternoon, within two hours after the trap was set. At this place fox and coyote tracks made well-marked trails in the sandy beds of washes.

A male and a female were trapped on the southeast side of Clark Mountain in May, 1939, using scent and jack rabbit meat for bait. The female, taken on May 22, was lactating. On the north side of the mountain numerous droppings of gray foxes were seen in washes, especially near thickets of *Garrya*. The droppings appeared as black blotches on the gravel, evidently the result of a plant diet with a decided cathartic effect.

In coloration the Providence Mountains gray foxes are satisfactorily referable to the pallid subspecies *scottii*. In fact, our specimens are noticeably paler, with less brownish effect, than others collected in 1910 along the lower Colorado River. Part or all of this difference may be due to dulling of the color in the 30-year interval since the latter series was taken.

Comparison of measurements of specimens from the Providence Mountains area with those of specimens from various localities along the Colorado River below Needles (see table 6) shows that the former differ in average greater size and relatively shorter tail, thus approaching the condition in the coastal subspecies *californicus* and *townsendi*.

Canis latrans estor Merriam

Coyote

8 mi. W Clark Mt., May 28 (sign); Pachalka Spring, Oct. 2 (sign); vicinity of Cima, Dec.–Jan.*; 5 mi. SE Cima, Dec. 28–Jan. 3*; Cedar Canyon, Jan. 6-8, May 26*; 5 mi. NE Granite Well, Dec. 31 (sign); 6 mi. S Granite Well, Dec. 20-22 (sign); Mitchell's, Dec.*; 2½ mi. SW Kelso, June 18-19; pass between Granite Mts. and Providence Mts., Dec. 10. Total specimens, 17.

Throughout the entire Providence Mountains area, coyotes were found in nearly every type of habitat. They were not detected among precipitous cliffs, as high on Clark Mountain and on the Providence Mountains proper. Judging from the results obtained by fur trappers, coyotes were widely and fairly

evenly distributed in winter over the lower parts of the mountains, the alluvial fans, and the valley bottoms. Possibly the summer distribution was more localized, because of the greater importance at that season of shade, water, and denning places.

Tracks of coyotes were common, along with those of kit foxes, jack rabbits, and kangaroo rats, on and about the sand dunes southwest of Kelso in June, 1938. A fully grown coyote loped along the edge of a wash within 50 yards of our camp on the evening of June 18, and less than an hour later two young coyotes ran about among creosote bushes about one-fourth mile to the east. Early the following morning, three coyotes, apparently fully grown, were seen as they crossed the wash one-half mile west of camp. These observations were all made within the first 24 hours after our arrival. In the next four days we saw no more coyotes at that place. A resident of Kelso said that he caught 40 coyotes in the previous winter within five miles of the town. The presence of a plentiful water supply at the Kelso sewer outlet may have made this vicinity especially favorable for coyotes.

Wintertime trapping of coyotes for fur was an industry or pastime engaged in by a large percentage of the human population, with varying degrees of intensity and of success. We gained the impression that more coyotes were taken than any other fur-bearing species, and because coyote pelts brought a higher price on the fur market than any others, with the exception of badgers, the species was by far the most valuable economically of all the wild vertebrates in the area. The most extensive and apparently most successful trapping was that carried on by itinerant professional trappers, who devoted all their time to the work and had traplines hundreds of miles in length. Two such trappers had temporary headquarters at the deserted site of Lanfair in the winter of 1937-38. They lived in cabin trailers and followed their traplines, all of which were along the roads, in light pickup trucks. One had a bloodhound to trail coyotes that dragged traps away from where they were set. Many local residents, including miners, ranch workers, railroad employees, and the operators of filling stations along the highway, each set a few traps for coyotes.

We heard no complaints of predation by coyotes on livestock, nor were there any reports of attempted coyote extermination campaigns. Many cattle, but no domestic sheep, were being grazed in the area. Cattlemen who were interviewed said that coyotes might occasionally kill calves, but they seemed to consider that the damage done was negligible.

A female trapped on May 26, 1938, at Cedar Canyon (no. 81801) was in worn pelage. The guard hairs over most of the body were extremely abraded, and on the sides and all of the back except a narrow median strip they were worn away or shed so that the dense mat of gray-brown underfur was exposed.

The 17 specimens from the area show the great amount of individual variation that occurs in most populations of coyotes. On the whole, the series is characterized by small size and reddish color as compared with specimens from localities farther north and west, and is referred to the race *estor*. The skull of a male (no. 79879) trapped, probably in December, 1937, by Walter Zeigler near Cima is unusually large (condylobasal length, 185.5 mm.; zygo-

matic breadth, 96.6 mm.), almost equaling the average of *lestes* (see Grinnell, Dixon, and Linsdale, 1937, vol. 2:474).

Canis lupus youngi Goldman
Gray Wolf

Old Barnett Mine, 12 mi. W Lanfair, about Dec. 14 (1 specimen).

An adult male wolf was trapped, at the old Barnett Mine, in 1922 by a trapper and homesteader named Watson. It was caught, supposedly by accident while it was pursuing a mountain sheep, in a no. 3 steel trap, which it dragged about 8 miles. The skull is now in the Museum of Vertebrate Zoölogy (no. 33389). A complete account, including the known details of the capture of this specimen, with measurements, photographs, and critical comments relative to the skull, has been published by Grinnell, Dixon and Linsdale (1937, vol. 2:526-532) under the name *Canis lycaon nubilis*. This is the only record known to us of the occurrence of wolves in the Providence Mountains area, or, for that matter, anywhere in southeastern California. Certainly the species has not been common there since white men came. No wolves were reported to us by stockmen or trappers in the course of our field work. It seems most probable that the individual captured was a straggler, such as might wander westward occasionally from Nevada or Arizona.

Subsequent to the assignment by Grinnell, Dixon, and Linsdale (*loc. cit.*) of the Providence Mountains specimen to the Great Plains subspecies *nubilis*, other subspecies have been distinguished and named by Goldman (1937) from the southwestern United States. The skull has therefore been reëxamined and its characters compared with those described for the new forms and with those of recently acquired specimens in the Museum of Vertebrate Zoölogy. In its shorter and broader skull, higher frontal shield, and greater posterior prolongation of nasals, our specimen resembles the southwestern "plains wolf" complex of subspecies as opposed to the northwestern "timber wolf" type, the latter represented by a series of 12 adult skulls of the subspecies *fusca* (for the use of this name in place of *gigas* see Allen and Barbour, 1937:230) from western Oregon. The three southwestern subspecies that range geographically nearest the Providence Mountains area are, in north to south sequence: *youngi*, *mogollonensis*, and *baileyi*.

Cranial measurements of the Providence Mountains specimens are as follows: greatest length of skull, 250.3 mm.; condylobasal length, 230.7; zygomatic breadth, 149.7; squamosal constriction behind zygomata, 80.1; width of rostrum (at constriction behind canines), 43.1; maxillary tooth row, 107.5; upper carnassial, crown length (outer side), 25.6; crown width, 14.9. The skull is larger and more massive than that of *baileyi* and has widely spreading zygomatic arches. In the latter character it exceeds any of the neighboring races, as is shown by the ratio of zygomatic breadth to condylobasal length of skull, which is 64.8 per cent (149/230.7 mm.) in the Providence Mountains specimen, as compared with 60.2 per cent (142.5/236.9 mm.) in the type specimen of *mogollonensis*, 56.5 per cent (137.3/242.8 mm.) in the type of specimen of

youngi (measured by Goldman, 1937:40), and 51.9 per cent (129.7/250) in the type specimen of *baileyi* (measured by Nelson and Goldman, 1929:166). All the specimens mentioned are adult males.

Subspecific assignment is here made provisionally. Providing the specimen with a new name is infeasible since the animal did not represent a permanent population of the area but was undoubtedly a straggler from some adjacent area regularly populated by wolves. Major E. A. Goldman has also studied this specimen in his review of the North American wolves, and the decision to assign it to the race *youngi* is based in part on our discussion of the problem with him.

Family Felidae

Lynx rufus baileyi Merriam

Bobcat

3 mi. N Cima, Jan. 10-12*; vicinity of Cima, Dec.–Jan. 10*; 5 mi. SE Cima, Dec. 20-27*; Rock Spring, about Jan. 1; Mitchell's, June, Nov.–Dec.*. Total specimens, 7.

Bobcats, as reported by trappers and as detected by us, occurred in considerable numbers at middle elevations in the area. The bases of the outlying spurs of the mountains, where there were small canyons, talus areas, and brush thickets, provided foraging grounds and retreats. They traveled out across the alluvial fans, usually following washes. Bobcats found in the vicinity of Cima, for example, were about three miles from rocky places. We found no sign of them below the yucca belt, but this apparent restriction is most likely due to the scarcity of rocky habitats at the lower elevations. Although a few individuals probably ranged through the piñon belt, we found bobcats only at its lower edge. The local range of bobcats was found to parallel closely that of Gambel quail, on which they probably preyed extensively.

Skins of one young and four adult bobcats, all winter-taken, are available from this area. These show the general reduction of dark marking characteristic of desert bobcats referred to the race *baileyi*, although there is considerable individual variation. The fur of a young individual, a female with permanent canines just appearing on December 25, is somewhat shorter and more silky and the broken black middorsal streaks are more clearly defined than are those of adults. Among the latter, a female taken sometime in November is conspicuously reddish, a condition that apparently results from the incomplete growth of the white-tipped guard hairs, which in the other three specimens, taken between December 20 and January 12, conceal the reddish underfur and impart a more frosted appearance and a softer texture to the pelage.

Family Sciuridae

Citellus tereticaudus tereticaudus (Baird)

Round-tailed Ground Squirrel

2½ mi. SW Kelso, June 18-23*; Colton Well, June 7-8*. Total specimens, 18. A specimen is recorded from Ivanpah by Howell (1938:187).

The finding of round-tailed ground squirrels at Colton Well and near Kelso, the two places where we carried on summertime field work at low elevation,

and the record of their occurrence at Ivanpah indicate that the species probably ranges widely over the lower parts of the alluvial fans and in the hot valley bottoms. The record from Colton Well, at 3,200 feet, is probably near the upper boundary of their altitudinal range in the area.

Burrows of these squirrels were in fine, loosely packed sand, either at the bases of water-cut banks or among the basal stems of creosote bushes and desert willows. The soil they burrowed in was, in all instances that we noted, deposited by wind. Near Kelso the burrows were numerous in the banks of a wash and in the wind-deposited mounds at the bases of clumps of trees and bushes, but there were no burrows in the coarser, water-worked sand of the bed of the wash. At Colton Well, there were burrows at the bases of creosote bushes on a nearly flat plain, but none on adjacent slopes where the soil was rockier. In the sand dunes southwest of Kelso, round-tailed ground squirrels found a suitable habitat in the pockets or basins among the small marginal dunes, where the force of the wind was broken by the surrounding ridges and the presence of sparse vegetation indicated, and helped maintain, a measure of permanence of the substrate. No water was available to the squirrels at any of the places we found them. In the period between June 18 and 23, 1940, we had ample opportunities to observe these squirrels near Kelso. They showed a remarkable ability to withstand extreme heat. The first individuals were seen and heard at about one-half hour after sunrise, when the temperature of the air was about 80°F. Activity was maintained throughout the day and ceased at sunset. Midday temperatures reached 115°F., or possibly higher, and during this period of greatest heat, the squirrels stayed in the sparse shade of the creosote bushes and desert willows much of the time. Although we saw them less frequently during the hottest part of the day, they squeaked constantly at us from their burrows and were readily caught in rat traps. Occasionally squirrels ran across openings in direct sunlight in places where the heat of the sand made walking uncomfortable even with thick-soled shoes.

One squirrel was seen climbing 5½ feet above the ground on the branches of a creosote bush. It moved with agility among the larger branches, but its activities seemed hampered by the bending of the finer twigs.

The abundance of individuals at this place resulted largely from the presence of many partly grown young. The approximate proportions of young and adults is indicated by the following record of specimens caught in a line of 15 rat traps set at 1:30 p.m., June 21, and visited three times in the course of the afternoon:

Time (p.m.)	Young	Adults
1:30-2:30	2 (1 ♂, 1 ♀)	
2:30-5:00	5 (3 ♂, 2 ♀)	2 (1 ♂, 1 ♀)
5:00-7:30	6 (2 ♂, 4 ♀)	1 (1 ♀)
Totals	13 (6 ♂, 7 ♀)	3 (1 ♂, 2 ♀)

On the following day, 14 of the traps were set in the same places and were visited twice. They caught 22 ground squirrels, of which only three were adults.

At this season the large, desert, kangaroo rats (*Dipodomys deserti*) were equally abundant in the same area and occupied essentially the same habitat as these ground squirrels. The burrows of one species were sometimes difficult to distinguish from those of the other, and at night the kangaroo rats foraged over the same ground that the squirrels had covered in the daytime. A ground squirrel that was frightened and ran into a burrow in broad daylight on the morning of June 19 was chased out of the burrow and pursued about three feet from the entrance by a kangaroo rat. Then both animals ran back into the same burrow, and neither reappeared within the next ten minutes.

The adults taken at this season were excessively fat. A male and a female that were caught on June 21 each had thick layers of fat beneath the skin and leaflike masses of fat inside the body cavity. Young individuals and an adult female that had recently nursed young had no such excess fat.

The series from near Kelso is Light Vinaceous-Cinnamon color on the upper parts in fresh summer pelage, and thus is characteristic of the subspecies *tereticaudus*. This color is best shown in the partly grown individuals that had recently acquired their first summer pelage in late June. Adults taken at the same time had probably molted into the summer pelage earlier in the season, and in them the dorsal color had faded toward yellow (between Pinkish Buff and Cinnamon-Buff). The glaringly bright light and high air temperatures to which these squirrels are exposed bring about rapid fading of the pigment in the hairs. Two specimens in juvenal pelage are paler (near Light Pinkish Cinnamon).

An adult in fairly fresh summer pelage from Colton Well differs from the Kelso series in being darker in color, between Vinaceous-Buff and Avellaneous, and a young individual from Colton Well is correspondingly darker than specimens of similar age from Kelso. There is thus an indication of geographic variation in color within the area. Further collecting might reveal that this species varies as greatly as pocket gophers and pocket mice in relation to soil color.

Citellus variegatus grammurus (Say)
Rock Squirrel

N side Clark Mt., 5,400 ft., May 29*; NW side Clark Mt., 7,300 ft., May 24; SE side Clark Mt., 6,300 ft., May 22; Mescal Spring, May 30; Mescal Cave, May 18*, May 30*; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, Jan. 6-7, May 20–June 1*; 5 mi. NE Granite Well, Dec. 28-29*; 6 mi. S Granite Well, Dec. 23; Mitchell's, June 10*; Snake Spring, June 23-25*. Total specimens, 16.

Rock squirrels were found at scattered localities throughout the piñon belt, but they were seldom abundant and, possibly because of their extremely wary nature, were not observed in many seemingly favorable situations. They were always among or near large rocks. The lowest altitude at which a rock squirrel was noted was 3,800 feet, 6 miles south of Granite Well on December 23, 1937. This locality was in the yucca belt, well below the lower edge of the piñons. Another was seen on May 24, 1939, running along the base of a cliff near snow banks at 7,300 feet altitude on the northwest side of Clark Mountain, at the edge of the white fir area.

On the dissected plateau north of Cedar Canyon, at altitudes from 5,000 to 6,500 feet, rock squirrels found favorable situations where weathered outcroppings of soft granite projected above the level of the piñon forest (fig. 10). The squirrels perched for long periods on the topmost rocks, with only the head and shoulders showing over the top if a human intruder was within sight. In the fissured cliffs and talus on the walls of the narrow canyons they were seen in fair abundance in late May and early June, 1938. Most of the individuals at this latter date were obviously young-of-the-year and were less wary than the adults.

Most of the foraging rock squirrels seen were in the bottoms of small canyons where they were apparently gleaning among the greener vegetation along the streambeds. A male shot near Ivanpah on May 15, 1938, had its mouth full of green grass heads. On the north side of Clark Mountain in May, 1939, two more were caught in steel traps set for carnivores; apparently they had been attracted by the meat and scent used for bait.

A squirrel was calling persistently from a projecting rock on a slope at Cedar Canyon on the afternoon of May 23, 1938. Its voice was shrill and clear, seemingly somewhat higher in pitch than that of *Citellus beecheyi* of the Pacific slope of southern California. The notes were short and somewhat metallic; some of them were followed by shorter second syllables on the same pitch but with less volume, as though the breath were being inhaled.

The sixteen specimens represent a variety of age groups and stages of pelage. The youngest individual, taken at Mitchell's on June 10, 1938, weighed 176 grams and measured 303 mm. in total length and 124 mm. in length of tail. No permanent premolars had appeared above or below, and the last molars had not yet erupted. Four other, larger specimens taken between May 29 and June 23 were obviously young-of-the-year, each with permanent premolars appearing beneath the deciduous premolars.

Ammospermophilus leucurus leucurus (Merriam)
Antelope Ground Squirrel

8 mi. W Clark Mt., May 28; N side Clark Mt., 5,000-5,400 ft., May 26-27*; NW side Clark Mt., 7,300 ft., May 20; Pachalka Spring, Oct. 2; SE side Clark Mt., 5,000-6,300 ft., May 17-22*; Mescal Spring, May 30, Oct. 4; Mescal Cave, May 18*, Oct. 4; 5 mi. SW Ivanpah, May 15; Purdy, April 26; 3 mi. N Cima, Jan. 9-11*; 2 mi. NNE Cima, May 12-15*; 5 mi. SE Cima, Jan. 5-8, May 20–June 3*; Government Holes, May 27; 2 mi. ESE Rock Spring, June 6*; 5 mi. NE Granite Well, Dec. 29–Jan. 6*; 3 mi. S Granite Well, Dec. 17-25*; Colton Well, June 7-8*, Oct. 5-6; Snake Spring, June 26; pass between Granite Mts. and Providence Mts., June 11, Dec. 11. Total specimens, 53. Howell (1938:172) records 4 specimens from Ivanpah and 3 from the "Providence Mountains" in the U. S. National Museum.

Antelope ground squirrels made up the most conspicuous element in the diurnal mammal population both in winter and in summer. They seemed able to survive in almost any habitat except the sandy valley bottoms and the sand dunes, where they were replaced by round-tailed ground squirrels. The presence of rock ledges, boulders, talus, or soil that was gravelly or at least hard packed seemed essential for existence of antelope ground squirrels, whereas variations in temperature, type of vegetation, and proximity of water had secondary

effects, influencing numbers of individuals present. At Cedar Canyon they were especially abundant along the sloping north wall, where isolated boulders and small patches of talus provided refuge places and lookout posts; they foraged among Joshua trees, sagebrush, and currant bushes in the wash, and in the piñon forest on the plateau above. South of Granite Well conditions seemed somewhat less favorable, but still adequate to support a sparse population of squirrels. At this place they used shrubs and clumps of *Yucca mohavensis* for observation posts, in the absence of large rocks, and foraged over rolling, gravelly terrain among scattered creosote bushes. When frightened they took refuge in burrows at the bases of shrubs and yucca clumps.

It is not known whether the absence of antelope ground squirrels in the sandy and silty valley bottoms results from their inability to find or make adequate refuge places in the absence of rocks or rocky soil or from an inability to compete with the more specialized round-tailed ground squirrels. Knowledge of the adaptable nature of the antelope squirrels leads one to favor the latter alternative. Were the habitat not already occupied by another species, they could probably live at least along the washes where the roots of creosote bushes and desert willows would furnish protection for burrow entrances. Whatever the reason, the two species are distinctly segregated on the basis of soil texture. Where a wash emerged on a nearly level plain from between rocky hills near Colton Well, antelope ground squirrels inhabited the banks and bed of the wash and the adjacent hill slopes, whereas round-tailed ground squirrels had their borrows in fine sand under creosote bushes only a few yards away.

There was no indication that antelope ground squirrels hibernated. On sunny days in December and January they were out in large numbers. Low temperatures seemed to have no appreciable effect in reducing their activity, although cloudy weather did. Thus, at Cedar Canyon, on January 8, 1938, they perched in exposed places on the tops of granite boulders in the bright sunlight, but also in a bitterly cold wind. At 6 miles south of Granite Well they were fairly abundant between December 19 and 21, 1937, in clear, cold weather. On December 22 and 23 the skies were overcast and the temperature rose with the approach of a rain storm, and in this period scarcely any ground squirrels were active above ground. In the winter the greatest activity took place near midday whereas in the summer the squirrels appeared soon after sunrise, maintained a high level of activity until about 10 a.m., and were relatively quiet during the remainder of the day.

The breeding season started early. Near Granite Well males had greatly enlarged testes on January 25. Our sets of steel traps at this locality were regularly disturbed by female antelope ground squirrels, which dug up the soft paper used to cover the traps, apparently for nest-building purposes. One female which was caught in a large steel trap had its mouth and cheek pouches stuffed with fur that it had plucked from the bait, a dead jack rabbit. None of the females collected in the winter, up to January 11, were noted to contain embryos. When we resumed field work in May, families of young squirrels were conspicuous. The youngest specimen, a female taken on May 26, 1939, at 5,400 feet altitude on the north side of Clark Mountain, weighed 23.8 grams

and had not yet erupted the last two molar teeth on each side. That the breeding season may be greatly prolonged is indicated by the presence of 7 embryos, each 20 mm. long, in a female taken on Clark Mountain on May 22, 1939. This instance is an exception to the general rule, stated by Grinnell (1914:222) and by Grinnell and Dixon (1918:692), that in desert areas ground squirrels complete the breeding cycle before the advent of hot weather.

All the winter-taken specimens, representing dates ranging from December 19 to January 11, are in full winter pelage. The adults taken in May and early June show various stages in the attainment of summer pelage. In most of the specimens this is present only about the mouth and parts of the head. Four females, two taken on May 21 and May 22 on Clark Mountain (including the pregnant female mentioned), a third taken on June 6 near Rock Spring, and a fourth taken on June 8 at Colton Well, have the summer pelage nearly or entirely complete.

Considering the abundance and conspicuousness of this species, especially when families of young first emerge in the spring, it is not surprising that numerous predatory species should capture them. The stomachs of three speckled rattlesnakes (see p. 275) taken in May and October contained remains of antelope ground squirrels. A gopher snake had caught one of a family of young squirrels and was killing it by constriction on May 27, 1939, on the north side of Clark Mountain. An adult and several other young squirrels were running excitedly about the snake. The squirrel was limp and seemingly dead when taken from the snake, but after 15 minutes it revived and seemed unharmed. A road-runner that was shot near Snake Spring on June 25, 1940, was carrying a recently killed young antelope ground squirrel in its bill.

Eutamias panamintinus panamintinus (Merriam)
Panamint Chipmunk

N side Clark Mt., 5,400 ft., May 24*; NW side Clark Mt., 7,400 ft., May 20-28; SE side Clark Mt., 6,300 ft., May 17-19*; Mescal Cave, May 18*, May 30*; 5 mi. SW Ivanpah, May 15*; Cedar Canyon, Jan. 5-8*, May 20–June 4*; Government Holes, May 27; 5 mi. NE Granite Well, Dec. 28–Jan. 5*; Mitchell's, June 9, Dec. 25; Snake Spring, June 23; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 56. Howell (1929:79) records one specimen from the New York Mountains and 4 from the Providence Mountains, about 24 miles northwest of Fenner.

The range of chipmunks within the area is divided into two parts. The northern part includes Clark Mountain and the Mescal Range, from 5,400 feet altitude to the summits of the highest peaks. The southern part extends the length of the New York–Providence Range, from the vicinity of Ivanpah southwestward to the Granite Mountains at elevations above 4,500 feet. In the pass between the Granite Mountains and the Providence Mountains, chipmunks were found as low as 4,100 feet. The species reaches its southernmost limit in the forested parts of the Granite Mountains, a few miles outside the area. The local range of the species as thus outlined is practically identical with that of piñons and includes all the Upper Sonoran Zone. The two parts of the range are separated by a gap about 15 miles wide of Lower Sonoran Joshua tree association that is wholly unsuitable for chipmunks. Such a circumstance

is not unusual in this species, which occupies a discontinuous range in the piñon woodlands of the mountains of southeastern California and southwestern Nevada.

The habitat most favorable to chipmunks consisted of fissured rock ledges or outcrops in the piñon belt. They seemed to depend entirely on the rocks for shelter. Although the chipmunks climbed freely in the piñons and probably obtained food from them in the form of seeds in years when good crops were produced, the fact that the piñon seed crop is uncertain and that the trees rarely furnish suitable refuge or nesting sites lead to the conclusion that the close correspondence between the local ranges of the chipmunks and the piñons results from similar tolerance to some environmental factor, probably temperature, rather than dependence of one species on the other.

At Cedar Canyon chipmunks were particularly abundant in January and again in May and June, 1938, on the piñon-covered plateau and the walls of the narrow side canyons cutting through it on the north side of the main canyon. They rarely ventured far from rocks. When alarmed, they sought refuge in fissures in cliffs and ledges or in spaces under granite boulders. Frequently they perched on the tops of rocks, where they could see for a hundred yards or more in all directions and from which they could retreat quickly into crevices if danger threatened. In such places they shelled the seeds they had gathered from the surrounding area, leaving little heaps of the broken shells of piñons and other seeds. They utilized smaller rocks and smaller crevices than did the rock squirrels in the same general area, and they avoided the sunny south-facing slopes and adjacent sandy washes that were occupied by antelope ground squirrels.

In January chipmunks were active and conspicuous on clear days even when cold winds were blowing, but on cloudy and rainy days they kept out of sight. At this season the period of greatest activity came near the middle of the day. In May and June activity commenced at sunrise, reached a peak at about 9 a.m., fell off during the hot part of the day, and was resumed in the late afternoon. Usually there were no chipmunks evident after sunset, but sometimes in the early evening they were seen foraging over cliffs that were still warm and that during most of the day had been strongly heated by the sun.

Breeding took place early in the spring. Males collected between December 29 and January 7 had enlarged testes. Nearly all the young had been born by the middle of May; only one of the females taken after that time contained embryos. This individual, taken on May 18, 1939, on the southeast side of Clark Mountain, had four embryos, each 14 mm. long. The oldest summer-taken individual that was undoubtedly born the same year is a specimen, shot on May 21, 1938, at Cedar Canyon, in which the permanent fourth upper premolars are fully grown but not worn; the youngest, a specimen taken at the same place on May 25, weighed 33.0 grams and had just attained the last molars but retained the deciduous premolars.

The juvenal pelage is complete in the young individual last mentioned and it is retained on the rump and the hind legs of a slightly older individual taken on May 15 near Ivanpah. All the other young-of-the-year had molted,

completely or nearly so, into the first summer pelage by May 20. Most of the adults taken in the period between May 15 and June 11 were in various stages of the spring molt, some with a barely discernible patch of fresh summer pelage on the nose, others with an equally inconspicuous remnant of the worn winter pelage at the base of the tail. None had molted completely by this time. A male taken on June 11, the latest in the season, had summer pelage on about half the body. All the chipmunks taken between December 29 and January 8 were in full winter pelage.

The chipmunks of the Providence Mountains area are here referred to the subspecies *panamintinus* in the absence of any constant characters differentiating them from topotypes and other specimens of that race from the Panamint Mountains (Johnson, 1943:95).

Family Geomyidae

Thomomys bottae providentialis Grinnell

Botta Pocket Gopher

8 mi. W Clark Mt., May 26, 28 (burrows); Pachalka Spring, May 28–June 1*; N side Clark Mt., 5,400 ft., May 27-28*; SE side Clark Mt., 6,300 ft., May 17-22*; borders of Ivanpah Lake bed, March 20 (burrows); 3 mi. N Ivanpah, April 25*; 5 mi. N Kelso Peak, Dec. 14*; 3 mi. N Cima, Jan. 9-12*; 2 mi. NNE Cima, May 16-17*; Cedar Canyon, Jan. 6, May 24-31*; 2 mi. ESE Rock Spring, June 5*; Purdy, April 26-27*; 5 mi. NE Granite Well, Dec. 27–Jan. 6*; 6 mi. S Granite Well, Dec. 18-25*; Snake Spring, June 23-25*; pass between Granite Mts. and Providence Mts., Dec. 9-11*; 12 mi. NW Essex, Dec. 9 (burrows). Total specimens, 62.

Burrows of pocket gophers were most numerous in the scattered patches of mellow soil near the bases of the mountains, at elevations between 4,000 and 5,000 feet. In such places the shrubby and herbaceous vegetation was relatively abundant, and the finely divided, loosely packed soil was moist enough to facilitate digging. At higher and at lower elevations circumstances seemed less favorable for pocket gophers, and their workings were correspondingly fewer. About the cliffs and in deep canyons high in the mountains the scarcity of soil and the extremely rocky nature of what little soil was present made suitable habitat rare. In the bottom of a canyon at 6,300 feet on the southeast side of Clark Mountain burrows were in soil that was filled with fragments of broken rock. At the opposite altitudinal extreme, no sign of pocket gophers could be found in June, 1940, in the fine sand near Kelso at 2,100 feet. The only place at which they were recorded in the area below 3,600 feet is the border of the dry Ivanpah Lake bed, where fresh burrows were noted among *Atriplex* bushes on March 29, 1917. At Pachalka Spring the gophers burrowed in moist, black soil in a peach orchard and also in dry, gravelly soil in the surrounding area.

The burrow openings and mounds were usually clustered about the bases of shrubs. Certain advantages accrued to the gophers through this choice of position. The ground was prevented from drying out by the shade of the leaves and branches and by the accumulation of litter; in this moist condition it was better suited for digging. The overhanging branches and foliage provided a protective screen from swooping or pouncing predators at the critical moments

when the pocket gophers appeared at the burrow entrances to push out dirt, and the lower branches and roots provided a measure of protection against such excavating predators as badgers. Finally, and more directly, the lower branches of some shrubs, including ephedra, turpentine broom, and cactus, served as food. Workings were noted beneath the following kinds of shrubs: ephedra, creosote bush, rabbit brush, *Atriplex*, *Franseria*, and at least two species of cactus (*Opuntia*). On Clark Mountain where pocket gopher burrows came up under clumps of prickly pear, parts of the roots had been eaten and round holes had been bored in the pads that lay flat on the ground.

At the pumping station 3 miles north of Ivanpah a small patch of alfalfa was being raised by the caretaker in April, 1920. He reported that gophers had invaded the alfalfa from the surrounding area on several occasions, and that he had promptly "caught them out."

At Cedar Canyon the gopher population was practically restricted to the gently sloping "piedmont" area between the rocky walls and the sandy wash bed. It was noted that this same area supported a fairly good growth of filaree and perennial, fibrous-rooted grass of a kind that was being heavily grazed by cattle. The gophers were not feeding on these forage plants, but confined their activities to the bases of shrubs, most of which they had pruned back to small clumps. One kind of shrub in particular, turpentine broom (*Thamnosa montana*), grew in abundance and to good size on the rocky slopes from which gophers were absent. The few of these bushes that grew lower down on the piedmont area had been attacked by gophers, which had cut off most of the stems near the bases and left them lying dead on the ground. The growth of economically valuable grazing plants was thus being promoted through the destruction of shrubs by pocket gophers.

The presence of ropelike earth "plugs" lying on the ground at Purdy on April 26 and on Clark Mountain on May 17 attested to activity beneath snow.

Females containing embryos were taken at Purdy on April 26 and near Cima on May 16. There was one set each of 3, 4, 5, and 6 embryos. A young individual was caught above ground in a mouse trap on Clark Mountain on May 22. Two young caught on June 1 at Pachalka Spring weighed 57.0 and 60.3 grams respectively, and one taken June 25 at Snake Spring weighed 71.0 grams.

All the pocket gophers of the Providence Mountains area are here assigned to the subspecies *providentialis*, although there is detectable color variation between some of the populations. Of the six specimens collected between April 25 and 27, 1920, on which Grinnell (1931) based the race *providentialis*, four (the two from Ivanpah Valley and the type specimen and one other from Purdy) are in fresh, unworn summer pelage, and two (both from Purdy) are in worn winter pelage. Comparison of the former with more recently taken specimens in summer pelage reveals a general agreement in color among specimens from the following localities: Pachalka Spring, two miles north-northeast of Cima, two miles east-southeast of Rock Spring, and Snake Spring. Specimens from high on the slopes of Clark Mountain (one from 5,400 feet on the southeast side) are noticeably darker dorsally because of a greater amount of black on the tips of the individual hairs. The buffy color on the

underparts and on the subterminal bands of the hairs on the upper parts is about the same in all the series. The darker color of these Clark Mountain specimens is closely matched in one specimen in the series of seven from Cedar Canyon and in an individual in the Museum of Vertebrate Zoölogy (no. 92656) from 5,800 feet altitude on the north side of Potosi Mountain, Clark County, Nevada. The remaining six specimens from Cedar Canyon are pale, as in typical *providentialis*. Comparison of specimens in winter pelage reveals no significant departure from the color of the two topotypes from Purdy, and there is no important variation in cranial characters within the area. In body size, the dark-colored specimens from Clark Mountain may be smaller than the others, but the individuals available are so few and the difference is so slight that it might well be a matter of individual variation.

All the dark-colored pocket gophers mentioned above (including the one from Potosi Mountain) are from localities within the Upper Sonoran piñon belt, whereas the paler ones are from the Lower Sonoran yucca and creosote bush belts. The mixed series from Cedar Canyon is from a transitional area where piñons and yuccas are intermingled. Further collecting, which is greatly to be desired before taxonomic changes are made, might confirm the impression that a dark race inhabits the piñon belt on the series of peaks and ridges extending from the southern end of the Spring Range in Nevada south to the Providence Mountains. A situation similar to the one here encountered is described by Burt (1934:410) on Charleston Peak, Nevada, where *Thomomys bottae centralis* assumes slightly smaller size and darker coloration on the higher slopes.

Family Heteromyidae

Perognathus longimembris longimembris (Coues)
Silky Pocket Mouse

8 mi. W Clark Mt., May 26*; N side Clark Mt., 5,000 ft., May 25*; SE side Clark Mt., 5,100-5,700 ft., May 22*; Mescal Spring, May 30*; 3 mi. N Ivanpah, April 25*; 2 mi. NNE Cima, May 14-17*; Cedar Canyon, May 26-27*; 2 mi. ESE Rock Spring, June 5*; Purdy, April 26-27*; Colton Well, June 8*; 2½ mi. SW Kelso, June 19-23*; Snake Spring, June 24-25*. Total specimens, 68. Huey (1939:56) records 8 specimens from 1 mile west of Mountain Pass under *Perognathus longimembris panamintinus*.

These little pocket mice were found in summer at elevations up to 5,700 feet. Apparently they were hibernating in December and January, because we caught none in those months. They occurred in the valley bottoms and over all parts of the alluvial fans, on soil varying in texture from fine, wind-deposited sand, as near Kelso, to mixed silt and gravel, as on Clark Mountain. Unlike the larger *Perognathus formosus*, they avoided cliffs and exceptionally rocky places. Individuals of *Perognathus longimembris* were caught near or beneath creosote bushes, Joshua trees, *Yucca baccata*, sagebrush, and bunch grass.

A Mohave rattlesnake was found which had half-swallowed an adult pocket mouse (see p. 275).

Females carrying embryos were taken on April 25, May 17, May 22, and May 25. The number of embryos per female varied from 2 to 6 and averaged 3.7. The earliest date represents a low altitude, 3,000 feet, 3 miles north of

Ivanpah. The record for May 25 is from 5,000 feet on the north side of Clark Mountain. Of 9 females caught near Cima on May 17, 1938, five contained embryos. Young-of-the-year were trapped near Kelso between June 19 and 23, 1940.

Of the currently recognized races of *Perognathus longimembris*, the Providence Mountains specimens most nearly resemble *P. l. longimembris* of the western Mohave Desert. Compared with a series of that race from near Peck's Butte, Los Angeles County, specimens from near Cima are indistinguishable on the basis of color, but differ in having slightly longer tails (averaging near 79 mm. rather than near 72 mm.) and a more depressed rostrum. The latter character apparently results from shorter incisors in the more eastern series. Topotypes of the races *panamintinus* from the Panamint Mountains and *virginis* from Saint George, Utah, are appreciably darker in color. The small size and relatively reduced bullae characteristic of the race *bangsi* of the Colorado Desert are not apparent in the Providence Mountains series, even among specimens from low elevations, and there is no appreciable deviation from the color of *longimembris* toward the extremely pallid condition of *bangsi* and of *bombycinus* from the lower Colorado River valley.

Perognathus formosus mohavensis Huey

Long-tailed Pocket Mouse

Pachalka Spring, May 31–June 1*; N side Clark Mt., 5,000-5,500 ft., May 24-27*; SE side Clark Mt., 5,100-5,700 ft., May 22*; Mescal Spring, May 30*; 3 mi. N Cima, Jan. 9-11*; Cedar Canyon, May 26–June 3*; 6 mi. S Granite Well, Dec. 19-21*; Colton Well, June 7-8; Mitchell's, Dec. 27*, June 9*; Snake Spring, June 25*; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 44. Huey (1938:36) records 6 specimens (one the type of *P. f. mohavensis*) from Bonanza King Mine.

Unlike the foregoing species, these larger pocket mice avoided level, sandy areas and inhabited the rocky hills and canyons near the bases of the mountains. A typical and apparently very favorable habitat was represented 6 miles south of Granite Well, where boulders from fragmented basaltic cliffs were scattered over fairly steep slopes. The pocket mice foraged over the coarse sandy soil and between the rocks. The altitudinal range in the area, as indicated by our records, was from 3,200 feet (at Colton Well) to 5,700 feet (on Clark Mountain). Locally the range of the species extended outward from the bases of the mountains to the extreme tips of the rocky hills and ended where these gave way to sandy alluvial fans. At the upper limits of their range, the mice were found about the bases of cliffs, usually in canyon bottoms where there was some sandy soil. Their decided preference for a rocky habitat brought them into contact with chollas and yuccas. Their mammalian associates included *Ammospermophilus leucurus*, *Peromyscus crinitus* and *Neotoma lepida*. There was no evidence of hibernation in this species. They were trapped as readily in December and January as in May and June.

A fairly prolonged breeding season is indicated by the fact that a female containing 3 embryos was taken at 5,000 feet on the north side of Clark Mountain on May 25, and two young-of-the-year in bluish juvenal pelage, weighing

11.2 and 11.9 grams, respectively, were trapped there on the same date. A young female weighing 13.7 grams was caught at Cedar Canyon on June 3, and two males taken on June 25 at Snake Spring weighed 16.7 and 17.5 grams. All the other specimens taken were in adult pelage.

Remains of a large pocket mouse, almost surely of this species, were found in the stomach of a sparrow hawk (see p. 285).

Dipodomys microps occidentalis Hall and Dale

Small-faced Kangaroo Rat

The only small-faced kangaroo rats that we found in the area were two adult males taken on the southeast side of Clark Mountain, at 5,100 feet, on May 22, 1939, when 100 mouse traps were set in fine soil in dry washes, and in rocky soil on the margins of the washes in the upper part of the yucca belt. A few scattered junipers were in the vicinity of the washes. These traps took no other species of *Dipodomys*. We did not trap in the yucca belt on the east side of Clark Mountain, but it appears that this kangaroo rat was not present in other parts of the area.

Dipodomys panamintinus caudatus Hall

Panamint Kangaroo Rat

3 mi. N Cima, Jan. 9*; 2 mi. NNE Cima, May 14-17*; Cedar Canyon, May 21–June 1*; 2 mi. ESE Rock Spring, June 5-6*; Purdy, April 26-27*; 5 mi. NE Granite Well, Dec. 28–Jan. 5*; 6 mi. S. Granite Well, Dec. 17-25*. Total specimens, 60.

Compared with *Dipodomys merriami* and *Dipodomys deserti* this species showed a decided preference for higher altitudes and coarser soils. Specimens were taken at elevations between 3,800 and 5,400 feet. The local range of the species thus was found to correspond closely with the distribution of yuccas, covering the upper slopes of the alluvial fans and penetrating at favorable places to flats in the mountains. At the lower elevations, as 6 miles south of Granite Well, where creosote bushes and Spanish dagger shared dominance, these kangaroo rats occurred in approximately equal numbers with the smaller *Dipodomys merriami* and were trapped in the sandy bed of a wash, in the eroded area of gullies and ravines bordering it, and over the broad, gently sloping alluvial fan. They avoided the vicinity of cliffs and areas of desert pavement. Northeast of Granite Well, this was the only species of kangaroo rat present, and it was abundant among sagebrush on a juniper-dotted flat. One individual was trapped in the piñon forest north of Cedar Canyon, but this was an exceptional occurrence with respect to habitat. Where artificial clearings among the yuccas had been abandoned for several years and supported a sparse growth of grass, *Erodium*, and weeds, these kangaroo rats were more abundant than in the surrounding undisturbed areas.

Each of four females trapped at Purdy on April 26 and 27, 1920, contained four embryos, and one taken at Cedar Canyon on May 21, 1938, had five embryos. The only young specimen was a male taken 2 miles east-southeast of Rock Spring on June 5, 1938. It was nearly fully grown but retained some

silky juvenal pelage and was on the verge of losing the deciduous premolars above and below.

Dipodomys merriami merriami Mearns
Merriam Kangaroo Rat

8 mi. W Clark Mt., May 26*; N side Clark Mt., 5,000 ft., May 25*; 3 mi. N Ivanpah, April 25*; 3 mi. N Cima, Jan. 9*; 2 mi. NNE Cima, May 13-17*; Purdy, April 26-27*; Cedar Canyon, Jan. 8*, May 27*; 2 mi. ESE Rock Spring, June 5*; 6 mi. S Granite Well, Dec. 17-25*; Colton Well, June 7-8*; 2½ mi. SW Kelso, June 19-23*; Snake Spring, June 24-25*; pass between Granite Mts. and Providence Mts., Dec. 10, June 11; 7 mi. N Essex, Dec. 22*. Total specimens, 100.

The Merriam kangaroo rat was present in most parts of the area at elevations between 2,100 and 5,100 feet. It did not occur in the piñon belt and was sparingly represented among the Joshua trees. It showed a decided preference for sandy soils but was more tolerant in this respect than was *Dipodomys deserti*, with which it occurred in the sand dunes southwest of Kelso and in the valley west of Clark Mountain. It was most abundant in the shallow sands of the desert washes and among creosote bushes and cholla. It occurred in limited numbers in rocky ravines in situations similar to those in which *Dipodomys microps* was found. Fifty traps were set in a clearing in the Joshua trees and 50 more were set in a nearby *Purshia*-covered flat near our camp east-southeast of Rock Spring, on June 5. Six *Dipodomys panamintinus* were taken in the clearing and two *Dipodomys merriami* were taken in the *Purshia*. In addition to the previously mentioned habitats, the Merriam kangaroo rat was found in open spaces near bushes in the yucca belt, around Joshua trees, and on rocky hillsides. Its range thus overlapped all or parts of the ranges of the other three species of kangaroo rats of the area.

Dipodomys merriami was most active soon after dark, as shown by our trapping south of Granite Well, on December 18 and 19. Here nine of them were caught in 95 traps before 7:45 p.m., and twelve were caught in 160 traps set in similar places in the remainder of the night. They were occasionally seen moving about outside of their burrows by day, but they were more nearly nocturnal than was *Dipodomys deserti*. *Merriami* was active at all season and under all weather conditions.

Two out of four females caught 3 miles north of Ivanpah on April 25 were pregnant, as was one out of two females taken at Purdy on April 27. Most of the females taken in May were pregnant, and one taken 2½ miles southwest of Kelso on June 22 contained two large embryos. The breeding season appeared to begin in April, reach its peak in May, and extend through June.

Dipodomys deserti deserti Stephens
Desert Kangaroo Rat

8 mi. W Clark Mt., 3,300 ft., May 26*; 2½ mi. SW Kelso, June 18-23*. Total specimens, 22.

This kangaroo rat occurs where fine sand is present to a depth of a foot or more. These conditions were present in the lowest part of the valley west of Clark Mountain and in the sand dunes southwest of Kelso. The sand was deeper and covered a much larger area at the latter locality, and desert kan-

garoo rats were more abundant here. Scattered creosote bushes were present in both areas. West of Clark Mountain, 155 traps took but two desert kangaroo rats on May 26, whereas 100 traps took an average of 12 per night in the dunes in late June. These kangaroo rats were less abundant near the edges of the dunes where the sand was shallower and the creosote bushes were closer together.

The presence of the desert kangaroo rat is easier to detect than that of the other kind of kangaroo rat occurring in the area because the burrows are commonly dug in mounds and are not closed in the daytime. The mounds used as sites for the burrows were often in open spaces but were usually under creosote bushes. These rats were often out of their burrows in day time. One adult was caught in a rat trap between 8:30 a.m., and 10:30 a.m., and an immature was taken between 10:30 a.m. and 1:00 p.m., on June 19. The temperature at 10:30 a.m. was 100°F. For interrelation with the round-tailed ground squirrel, see page 352.

Two half-grown desert kangaroo rats came into our camp southwest of Kelso at dusk on June 19. When oatmeal was thrown to them, they approached so closely that one was caught by hand. The other ran away but soon returned. They were not frightened by noises but would temporarily retreat when a sudden motion was made. At times they would turn around and kick dirt on the oatmeal with their feet. Another young kangaroo rat was caught in the same way on June 20.

The sexes were evenly divided in the 22 specimens that we caught. None of the females was pregnant. The youngest individual taken was half grown on June 19. It appears that the breeding cycle is completed early in the year.

Family CRICETIDAE

Onychomys torridus pulcher Elliot

Southern Grasshopper Mouse

Pachalka Spring, June 1*; SE side Clark Mt., 5,100 ft., May 22*; Mescal Spring, May 30*; 3 mi. N Cima, Jan 9-12*; 2 mi. NNE Cima, May 13-17*; Purdy, April 27*; Cedar Canyon, May 21–June 1*; 2 mi. ESE Rock Spring, June 5-6*; 5 mi. NE Granite Well, Dec. 30–Jan. 1*; 6 mi. S Granite Well, Dec. 19-24*; Colton Well, June 8*; Snake Spring, June 24-25*. Total specimens, 43.

The grasshopper mice were restricted mainly to the yucca belt, where they seemed to prefer the areas of coarse, firmly packed soil on the upper slopes of the alluvial fans. They penetrated into the mountains at places like Cedar Canyon, where there were gravelly benches above the washes and flats covered with sagebrush. They did not enter the piñon belt. Several days collecting near Kelso failed to produce any grasshopper mice in that low, sandy area. We did not find them below an altitude of 3,200 feet. Judging from the places in which they were trapped, these mice foraged principally over the areas of open ground between bushes. They were seldom caught beneath bushes and seemed to avoid rocky places. Individuals were taken in traps set in the following situations: on soil consisting of coarse, disintegrated granite on a flat covered with sagebrush; among cholla and yuccas; among Joshua trees; among *Purshia* bushes; on hard-packed soil with closely cropped grass and *Erodium;* at the

edge of an abandoned artificial clearing; and in the sandy bed of a wash. They were equally active in summer and in winter.

At each place where they were caught, grasshopper mice were outnumbered by one of the species of *Peromyscus*. Trapping results gave the impression that the grasshopper mouse population was thinly and uniformly spread over the area. It was seldom that more than one individual was caught in a line of 50 or 100 traps set overnight, yet this small percentage appeared regularly in the catch at each locality where conditions were favorable. Our 43 specimens include nearly all of the individuals trapped in the area.

Two pregnant females were taken, one at Purdy on April 27, with five embryos, the other near Rock Spring on June 5, with two embryos. The youngest grasshopper mouse trapped was a male weighing 15 grams taken on May 14 near Cima. Individuals in the bluish juvenal pelage were taken between that date and June 24.

Specimens taken in December and January can be divided into two age groups as determined by the extent of wear of the molar teeth. Those with the teeth less worn, so that the cusps are all plainly evident, are judged to be subadult individuals that were born in the previous spring or summer. They constitute a relatively uniform series characterized by rather dark dorsal coloration (near Wood Brown) and smaller size (weight averaging about 18 grams). In contrast are the fully adult individuals with the molars worn smooth. In these the dorsal coloration is brighter (near Avellaneous) and the size is greater (weight averaging about 21 grams). The subadult group is represented in our series by 18 individuals; the adult group by four. The abrupt cleavage of the winter population into two age groups and the relative predominance of the younger group appear to indicate that the normal life span for this mouse is between one and two years and that most individuals breed only during one season.

Assignment of the Providence Mountains specimens of *Onychomys torridus* to the subspecies *pulcher* is made with recognition that they represent a stage more or less intermediate between that pallid form and the darker *longicaudus* of southern Nevada and southwestern Utah.

Reithrodontomys megalotis megalotis (Baird)
Harvest Mouse

Pachalka Spring, June 1*; 5 mi. NE Granite Well, Dec. 30-Jan. 5*. Total specimens, 13.

Most of the Providence Mountains area is too arid for the requirements of harvest mice. The few mice of this species that do occur are restricted to the small valleys and basins high in the mountains or to the vicinity of the infrequent springs or seepage areas at lower elevations. A series from near Granite Well was taken in a sagebrush-covered flat at an altitude of 5,400 feet on coarse soil composed of disintergrated granite. A sparse growth of grass and annuals had encouraged a homesteader to clear the brush from part of the area at some time in the past. The only animal taken at Pachalka Spring was caught in a patch of green grass in an orchard below the spring; it was a female without embryos.

Peromyscus crinitus stephensi Mearns
Canyon Mouse

N side Clark Mt., 5,000-5,500 ft., May 25-27*; SE side Clark Mt., 5,100 ft. and 6,300 ft., May 17-22*; Mescal Spring, May 30*; 3 mi. N Cima, Jan. 9*; Cedar Canyon, Jan. 8 and May 28–June 3*; 5 mi. NE Granite Well, Dec. 29–Jan. 5*; 6 mi. S Granite Well, Dec. 17-24*; Colton Well, June 7*; Mitchell's, Dec. 27 and June 10*; 7 mi. NW Essex, Dec. 22*; pass between Granite Mts. and Providence Mts., June 11-25*. Total specimens, 77.

The canyon mouse was found throughout the area where broken or cracked rocks were arranged to form crevices. They were not common in gravelly places or about massive rocks. Their distribution was mainly determined by their requirement for crevices rather than by other environmental factors. This habitat was most abundant near the upper parts of the mesas at their junctions with the mountains at elevations between 4,000 and 5,500 feet. They were found in association with mesquite, Joshua trees, Spanish dagger and bayonet, creosote bush, squaw bush, sagebrush, cactus, and *Purshia.*

The four species of *Peromyscus* present in the area had different habitat preferences, with the canyon mouse occupying a central position. It was found with the piñon mouse in the rocky areas in the lower parts of the piñon belt, with the cactus mouse in the upper parts of the washes in the yucca belt, and with the deer mouse in the sagebrush belt. However, it appeared that the individuals taken in rocky places, other than those of the canyon mouse, were stragglers from other habitats.

Females with embryos were taken as follows: one each on May 23 and June 3 with three embryos, one each on May 26 and 27 with four embryos, and one each on May 25 and 30 with five embryos. Large young-of-the-year were taken on May 14, our earliest spring collecting date. Fifteen adult females taken between May 17 and June 8 were not pregnant.

Peromyscus eremicus eremicus (Baird)
Cactus Mouse

N side Clark Mt., 5,000-5,300 ft., May 25-27*; SE side Clark Mt., 5,100-5,700 ft., May 22*; Pachalka Spring, May 31–June 1*; Mescal Spring, May 30*; 3 mi. N Cima, Jan. 9-17*; Cedar Canyon, Jan. 7*; 5 mi. NE Granite Well, Dec. 29*; 6 mi. S Granite Well, Dec. 18-23*; Colton Well, June 7; Mitchell's, June 9; 2½ mi. SW Kelso, June 22*; 7 mi. NW Essex, Dec. 22*; pass between Granite Mts. and Providence Mts., June 24*. Total specimens, 39.

The cactus mouse was present between elevations of 2,000 and 5,700 feet. It occurred in small numbers in the flats in the creosote belt but showed a decided preference for the shallow washes in the yucca belt near the upper parts of the mesas. It was absent from the piñon belt and was scarce in sagebrush. Loose, gravelly soil in and on the margins of shallow washes in association with scattered yuccas and cacti provided optimum conditions for this mouse. Under such conditions, 14 were caught in 51 traps near our camp three miles north of Cima, on January 9. They were present in moderate numbers on the desert pavement and in the deeper washes at the bases of the mountains. They avoided strictly sandy soil and were seldom taken in the rocky areas that are preferred by the canyon mouse.

Of eleven adult females taken in May and June, only four were pregnant. Of these four, two taken on June 1 had two and four embryos, and two taken on May 30 each had five embryos.

Peromyscus maniculatus sonoriensis (LeConte)
Deer Mouse

SE side Clark Mt., 6,300 ft., May 17*; Mescal Spring, May 30*; 3 mi. N Ivanpah, April 25*; 3 mi. N Cima, Jan. 9*; 2 mi. NNE Cima, May 14*; Cedar Canyon, Jan. 7*; 2 mi. ESE Rock Spring, June 5*; Purdy, April 27*; 5 mi. NE Granite Well, Dec. 28–Jan. 4*; Everet Well (T11N, R15E), 5,030 ft., May 28*. Total specimens, 28.

The total number of *Peromyscus maniculatus* trapped in the area was markedly less than that of any of the other kinds of white-footed mice. In fact, *maniculatus* appeared to be abundant only in the sagebrush belt in and east of Cedar Canyon, in the yucca belt near Cima, and in fields that had been cultivated for a time and then abandoned. Common features of these areas were a loose, fine soil, a moderate to dense vegetative covering, and level terrain. One individual was taken in the piñon belt. None was caught in the creosote belt. A deer mouse was found in an abandoned cactus wren's nest that was situated about four feet above the ground in a Joshua tree.

Immature deer mice were collected on April 27. Two females taken two miles north-northeast of Cima on May 14 contained four and six embryos.

Peromyscus truei truei (Shufeldt)
Piñon Mouse

N side Clark Mt., 5,000-7,400 ft., May 24-29*; SE side Clark Mt., 5,100-6,300 ft., May 17-22*; Mescal Spring, May 30*; 2 mi. NNE Cima, May 17*; Cedar Canyon, Jan. 8, May 21-23*; Purdy, April 27*; 5 mi. NE Granite Well, Dec. 28–Jan. 5*; pass between Granite Mts. and Providence Mts., June 11*. Total specimens, 81.

The piñon mouse occurred from an altitude of 4,100 feet to the tops of the mountains, but was more abundant at the higher elevations. It preferred areas in which large boulders were present in proximity to piñons and junipers, but it also was present in smaller numbers in the sagebrush belt, in a field that had been cleared in the sagebrush and planted with corn, and in the upper part of the yucca belt. It thus occupied areas in common with the canyon mouse at the lower edge of the piñon belt and with the deer mouse in the yucca and sagebrush belts.

A young piñon mouse was caught on May 27. A female with four embryos was taken on May 30, and one with five embryos was taken on April 27. Fourteen adult females caught between May 17 and 27 did not contain embryos.

Neotoma lepida lepida Thomas
Desert Wood Rat

N side Clark Mt., 5,000-7,400 ft., May 25-29*; Pachalka Spring, June 1*, Oct. 2; 8 mi. W Clark Mt., May 26*; SE side Clark Mt., 5,100 ft., May 22*; Mescal Spring, May 30*; Mescal Cave, Oct. 4; 3 mi. N Cima, Jan. 11*; 2 mi. NNE Cima, May 17*; Cedar Canyon, May 24–June 3*; Government Holes, May 27*; 2 mi. ESE Rock Spring, June 5-6*; Purdy,

April 26*; 5 mi. NE Granite Well, Dec. 31–Jan. 6*; 6 mi. S Granite Well, Dec. 19–24*; Colton Well, June 7*, Oct. 5; Mitchell's, Dec. 27*; 7 mi. NW Essex, Dec. 22*; pass between Granite Mts. and Providence Mts., June 25*. Total specimens, 81.

Desert wood rats were present in all parts of the area except the sand dunes and the uniform stands of sagebrush. They seemed to be most abundant where large rocks were present along the margins of deep washes near the bases of the mountains, but they were also found in the washes in the floors of the valleys, in creosote bushes, in the yucca groves, on ledges and cliffs, in clearings, and in abandoned houses.

In the valley west of Clark Mountain, wood rat nests were placed under catclaws and in piles of rubbish that had been deposited by water on the margins of the sandy washes. Some nests were under creosote bushes away from the washes. Nests were numerous under fallen Joshua trees or in the trees where they forked near the ground, and about the bases of the smaller yuccas (fig. 51) and chollas. Little nesting material was added by the wood rats where plants formed a clump, although large piles of droppings showed long occupancy. Nests constructed among boulders and on ledges were usually larger than those in other places. Natural caves and abandoned mine tunnels were almost invariably inhabited by wood rats. A cave in a cliff near the upper end of a canyon on the southeast side of Clark Mountain contained at least a ton of droppings. Intensive trapping in the boulders and at the bases of cliffs in the white fir belt on Clark Mountain took only desert wood rats. It was thought that *Neotoma cinerea* might occur here. Unusual occurrences of wood rats were in piñons away from rocks in Cedar Canyon and in the marshy area near

Fig. 51. Desert wood rat nest in clump of Spanish bayonet 2 miles north-northeast of Cima. Photograph taken May 15, 1938.

Mescal Spring. These were young animals, which appeared to wander more widely than did the adults.

Wood rats were most active at night but were often seen in the daytime as they ran between boulders and from one plant to another. Two were caught in the course of a rainstorm at Mitchell's on December 27. One was caught in a trap set in a tunnel of a pocket gopher. Another was found dead in an open water tank at Government Holes.

Botfly warbles were found on the throats of wood rats taken on the southeast side of Clark Mountain on May 30 and south of Granite Well on December 19.

Females containing four embryos each were trapped on May 17, May 26, and June 1, and a half-grown female taken on May 26 had three embryos in one horn of the uterus. Many young wood rats were caught in mouse traps in May and June, and immature individuals were present at all times that we were in the area. Twelve adult females trapped between May 6 and June 5 did not contain embryos. A young wood rat was found on June 5 in a small, open nest situated a short distance from a large nest.

Family Erethizontidae

Erethizon epixanthum Brandt

Yellow-haired Porcupine

The only porcupine seen in the area was taken in the piñon belt near our camp 5 miles northeast of Granite Well at an elevation of 5,400 feet, on December 28. The animal was found at night in a piñon. It was making a grunting noise.

Many of the piñons in the area northeast of Granite Well and in Cedar Canyon had been stripped of the bark on the limbs and trunks, sometimes resulting in the death of the limb or tree. Droppings and quills were found in the talus at the base of a pinnacle on the north wall of Cedar Canyon on May 28. Mr. Murphy, who has ranched in the Providence Mountains area since 1914, told us that porcupines were more abundant in the New York Mountains than elsewhere in the area. We did not find porcupines on Clark Mountain.

The specimen is a young male in which the third molar has not yet erupted. It therefore cannot be allocated as to subspecies, since the only valid criteria for distinguishing *E. e. epixanthum* and *E. e. couesi* are skull dimensions (see Hall, 1946:585). *Couesi* has been reported from Clark County, Nevada, adjoining the Providence Mountains area.

Family Leporidae

Lepus californicus deserticola Mearns

Black-tailed Jack Rabbit

N side Clark Mt., 5,200 ft., May 28; Pachalka Spring, Oct. 2; 8 mi. W Clark Mt., May 26; SE side Clark Mt., 5,700-6,300 ft., May 20*, Oct. 3; Purdy, April 26; 2 mi. NNE Cima, May 13*; 5 mi. N Kelso Peak, 4,000 ft., Dec. 13; Cedar Canyon, Jan. 8*; Government Holes, May 27; 5 mi. NE Granite Well, Jan. 2*; 6 mi. S Granite Well, Dec. 20*; 2½ mi. SW Kelso,

June 19; Colton Well, June 7, Oct. 6; pass between Granite Mts. and Providence Mts., Dec. 11. Total specimens, 9.

Jack rabbits were present throughout the area at elevations between 2,000 and 6,300 feet. They were abundant in 1920, and from 1937 through 1940, but only five jack rabbits were seen between October 1 and 7, 1945, during which time most parts of the area were visited. The residents of the area that we talked to agreed that a sharp decrease in the numbers of jack rabbits and cottontails occurred in 1942, and that there had been no perceptible increase since that time.

Jack rabbits preferred the desert washes and the rough terrain of the upper part of the yucca belt. In these places they were most often found sitting in the

FIG. 52. One of litter of five black-tailed jack rabbits found 2 miles north-northeast of Cima. Photograph taken May 13, 1938.

shade of catclaw, desert willow, yucca, cacti, and boulders. They were not uncommon in the flat parts of the yucca belt (fig. 39), in sagebrush (figs. 5 and 9), and in the lower parts of the canyons. Only rarely did they go into the creosote bush flats, or the piñon association.

The only female that we took in the spring (May 20) was not pregnant. A female was seen in the yucca belt north-northeast of Cima on May 13 that appeared reluctant to leave when approached. A search revealed five young (fig. 52) hidden beneath a bush. These varied in total length from 168 to 176 mm. and in weight from 80.0 to 105.8 grams. They were unable to walk.

Sylvilagus audubonii arizonae (Allen)

Audubon Cottontail

N side Clark Mt., 5,000 ft., May 24-27*; 8 mi. W Clark Mt., May 26; Mescal Spring, May 29; 2 mi. NNE Cima, May 15*; 5 mi. N Kelso Peak, Dec. 13; Cedar Canyon, May 22*; Government Holes, May 27; 5 mi. NE Granite Well, Jan. 1*; 5 mi. S Granite Well, Dec.

18*; Colton Well, June 7 and Oct. 6; pass between Granite Mts. and Providence Mts., June 24*. Total specimens, 12.

Audubon cottontails were abundant from 1937 to 1940 in the upper and rougher parts of the yucca belt and in the desert washes at lower elevations. Their altitudinal range was between 3,300 and 5,400 feet. Occasionally individuals were present in the piñon belt adjacent to areas where yuccas predominated, and they were fairly numerous in areas where sagebrush and juniper were present in open stands, as at Government Holes and in the east end of Cedar Canyon (figs. 9 and 10). They were not seen in the sand dunes, the creosote habitat, or in the piñon belt and canyons at higher elevations. They seemed to be less able to tolerate high temperatures than the jack rabbits and stayed closer to brushy places. The factor of protection was also important in the selection of such habitats, since they were elusive in the cover immediately after being flushed. They lacked the endurance in running which the jack rabbits possessed.

Seven cottontails were seen in a desert wash below Mescal Spring within a distance of one mile on the morning of May 29, 1939, and about 25 were seen on December 18, 1937, in two hours' observation on a plateau near our camp six miles south of Granite Well. This contrasts sharply with the situation in October, 1945, when only three cottontails were seen in seven days of observation in the area.

Two dead cottontails were found on January 2, in the bottom of a vertical mine shaft northeast of Granite Well. On May 28 in a desert wash west of Clark Mountain a dead rabbit was found that had been partly swallowed, presumably by a rattlesnake. It was about three-fourths grown.

A female collected at Cedar Canyon on May 28 contained two embryos. When this female was plucked, the new hairs showed clearly the irregular pattern of the spring molt. Young rabbits were present in May and early June.

Family Bovidae

Ovis canadensis nelsoni Merriam

Mountain Sheep

N side Clark Mt., 6,000-7,300 ft., May 29 and Oct. 3; SE side Clark Mt., 6,500-7,000 ft., May 17-20; 5 mi. SW Ivanpah, 5,000 ft., May 15; 6 mi. S Granite Well, Dec. 18; 2½ mi. SW Kelso, June 19*; Mitchell's, 5,300-6,300 ft., June 9 and Dec. 25*; pass between Granite Mts. and Providence Mts., 4,600 ft., June 23. Total specimens, 4.

With one exception, our records of the presence of mountain sheep in the area are from elevations of 4,500 feet or greater. The exception was the presence of the skull of a lamb in a desert wash southwest of Kelso, at an altitude of 2,100 feet. This lamb may have been either killed here or brought in by a predator. We know that bighorns occur in the low, flat parts of the creosote belt as they travel from one range to another, but our study indicated that they were mainly confined to the rocky parts of the mountains, where there were shady resting places. These were usually in the shadows of cliffs, but they were also under firs, piñons, yuccas, or other trees and shrubs.

Tracks and feces of bighorns were found on Clark Mountain in May, 1939,

and October, 1945, and in the Providence Mountains in December, 1937, May and June, 1938, and June, 1940. Mr. Murphy, who has ranched in the area for many years, told us that sheep were common in the Providence Mountains when he first came there in 1914, and that they had been rare since 1922. Mr. John Tunney, of Essex, who has prospected in the area since 1920, said that he saw 19 sheep in one band on Clipper Mountain in 1929, and seven sheep in the Old Woman Mountains (south of the area) in June and July, 1943. All the residents to whom we talked said that the reduction in numbers was the result of hunting.

Hildebrand was descending a shoulder of the Granite Mountains on the southwest side of the pass between the Granite and Providence mountains, at 6 a.m. on June 23, 1940, when he saw a young bighorn. It had been resting under a bush and would have gone unnoticed had it not started running. It ran rapidly across an area of large, granite boulders. No other sheep and but few tracks were seen in this vicinity.

LITERATURE CITED

Allen, G. M., and Barbour, T.
1937. The Newfoundland wolf. Jour. Mamm., 18: 229–234, 1 fig.

Arvey, M. D.
1941. A new race of bush-tit from southeastern California. Condor, 43: 74–75.

Bogert, C. M.
1939. A study of the genus *Salvadora*, the patch-nosed snakes. Publ. Univ. Calif. Los Angeles Biol. Sci., 1: 177–236, 5 pls., 2 figs. in text, 2 maps.

Burt, W. H.
1934. The mammals of southern Nevada. Trans. San Diego Soc. Nat. Hist., 7: 375–428, 1 map.

Dalquest, W. W.
1946. A new name for the desert race of the bat, *Myotis californicus*. Proc. Biol. Soc. Wash., 59: 67–68.

Dice, L. R.
1943. The biotic provinces of North America (Ann Arbor: University of Michigan Press), viii + 78 pp., 1 map.

Dunn, E. R.
1922. A suggestion to zoogeographers. Science, 56: 336–338.

Goldman, E. A.
1937. The wolves of North America. Jour. Mamm., 18: 37–45.

Goldman, E. A., and Moore, R. T.
1945. The biotic provinces of Mexico. Jour. Mamm., 26: 347–360, 1 fig.

Grinnell, J.
1908. The biota of the San Bernardino Mountains. Univ. Calif. Publ. Zoöl., 5: 1–170, 24 pls.
1914. An account of the mammals and birds of the Lower Colorado valley. Univ. Calif. Publ. Zoöl., 12: 51–294, 11 pls., 9 figs. in text.
1923*a*. The present state of our knowledge of the gray titmouse in California. Condor, 25: 135–137, 1 fig.
1923*b*. Observations upon the bird life of Death Valley. Proc. Calif. Acad. Sci., ser. 4, 13: 43–109, 1 fig.
1931. A new pocket gopher from southeastern California. Univ. Calif. Publ. Zoöl., 38: 1–10, 2 pls.
1934. Further observations upon the bird life of Death Valley. Condor, 36: 67–72.
1937. Mammals of Death Valley. Proc. Calif. Acad. Sci., ser. 4, 23: 115–169.

Grinnell, J., and Dixon, J.
1918. Natural history of the ground squirrels of California. Monthly Bull. Calif. State Comm. Horticulture, 7: 593–708, 5 pls., 30 figs. in text.

Grinnell, J., Dixon, J., and Linsdale, J. M.
1937. Fur-bearing mammals of California (Berkeley: Univ. Calif. Press), vol. 2, xiv + 377–777 pp., 6 pls., 207 figs. in text.

Grinnell, J., and Miller, A. H.
1944. The distribution of the birds of California. Pac. Coast Avif. No. 27: 1–608, 57 figs., frontis.

Grinnell, J., and Swarth, H. S.
1913. An account of the birds and mammals of the San Jacinto area of southern California. Univ. Calif. Publ. Zoöl., 10: 197–406, 5 pls., 3 figs. in text.

HALL, E. R.
1946. Mammals of Nevada (Berkeley: Univ. Calif. Press), xi + 710 pp., 11 pls., 485 figs., frontis.

HALL, H. M., and GRINNELL, J.
1919. Life-zone indicators in California. Proc. Calif. Acad. Sci., ser. 4, 9: 37–67.

HOLLISTER, N.
1908. Birds of the region about Needles, California. Auk, 25: 455–462, 8 pls.

HOWELL, A. H.
1929. Revision of the American chipmunks (genera *Tamias* and *Eutamias*). N. Amer. Fauna No. 52: 1–157, 10 pls., 9 figs. in text.
1938. Revision of the North American ground squirrels, with a classification of the North American Sciuridae. N. Amer. Fauna No. 56: 1–256, 32 pls., 20 figs. in text.

HUEY, L. M.
1938. A new form of *Perognathus formosus* from the Mohave Desert region of California. Trans. San Diego Soc. Nat. Hist., 9: 35–36.
1939. A new silky pocket mouse from southwestern Utah. Trans. San Diego Soc. Nat. Hist., 9: 55–56.

JOHNSON, D. H.
1943. Systematic review of the chipmunks (genus *Eutamias*) of California. Univ. Calif. Publ. Zoöl., 48: 63–148, pl. 6, 12 figs. in text.

KLAUBER, L. M.
1931. A new subspecies of the California boa, with notes on the genus *Lichanura*. Trans. San Diego Soc. Nat. Hist., 6: 305–318, 1 pl., 1 map.
1932. Amphibians and reptiles observed enroute to Hoover Dam. Copeia, 1932: 118–128.
1936. *Crotalus mitchellii*, the speckled rattlesnake. Trans. San Diego Acad. Sci., 8: 149–184, 2 pls., 3 figs. in text, 1 map.
1939. Studies of reptile life in the arid southwest. Bull. Zoöl. Soc. San Diego, 14: 1–100, 1 map.
1941. The long-nosed snakes of the genus *Rhinocheilus*. Trans. San Diego Soc. Nat. Hist., 9: 289–332, pls. 12–13, 1 map.
1945. The geckos of the genus *Coleonyx* with descriptions of new subspecies. Trans. San Diego Soc. Nat. Hist., 10: 133–216, 2 maps.

LIVINGSTON, B. E., and SHREVE, F.
1921. The distribution of vegetation in the United States, as related to climatic conditions. Carnegie Inst. Wash. Publ. 284: i–xvi + 1–585, 72 pls., 74 figs. in text, 1 map.

MAYR, E.
1946. History of the North American bird fauna. Wilson Bull., 58: 3–41, 4 figs.

MERRIAM, C. H.
1898. Life zones and crop zones of the United States. U. S. Dept. Agr. Bur. Biol. Surv., Bull. 10: 1–79, 1 map.

MICHENER, H., and MICHENER, J. R.
1931. Variation in color of male house finches. Condor, 33: 12–19.
1940. The molt of house finches of the Pasadena region, California. Condor, 42: 140–153, 1 fig.

MILLER, A. H.
1940. A Transition island in the Mohave Desert. Condor, 42: 161–163.
1941. Speciation in the avian genus *Junco*. Univ. Calif. Publ. Zoöl., 44: 173–434, 33 figs. in text.
1946. Vertebrate inhabitants of the piñon association in the Death Valley region. Ecology, 27: 54–60.

NELSON, E. W., and GOLDMAN, E. A.
1929. A new wolf from Mexico. Jour. Mamm., 10: 165–166.

PARISH, S. B.
1930. Vegetation of the Mohave and Colorado deserts of southern California. Ecology, 11: 481–499, 9 figs.

RODGERS, T. L., and FITCH, H. S.
1947. Variation in the skinks (Reptilia: Lacertilia) of the *skiltonianus* group. Univ. Calif. Publ. Zoöl., 48: 169–220, pls. 8–10, 9 figs. in text.

SIBLEY, C. G.
1940. The warbling vireo of the Cape district of Lower California. Condor, 42: 255–258, 2 figs.

STEPHENS, F.
1903. Bird notes from eastern California and western Arizona. Condor, 5: 75–78, 100–105.

STORER, T. I.
1925. A synopsis of the Amphibia of California. Univ. Calif. Publ. Zoöl., 27: 1–342, 18 pls., 42 figs. in text.

SWARTH, H. S.
1905. *Atratus* versus *Megalonyx*. Condor, 7: 171–174, 1 map.
1910. Two new owls from Arizona, with description of the juvenal plumage of *Strix occidentalis occidentalis* (Xantus). Univ. Calif. Publ. Zoöl., 7: 1–8.
1913. A revision of the California forms of *Pipilo maculatus* Swainson, with description of a new subspecies. Condor, 15: 167–175, 1 map.

VAN DENBURGH, J.
1922. The reptiles of western North America. Occas. Papers Calif. Acad. Sci., 10: 1–1028, 28 pls.

VAN ROSSEM, A. J.
1936. Birds of the Charleston Mountains, Nevada. Pac. Coast Avif. No. 24: 1–65, 13 figs. in text.
1945*a*. The eastern distributional limits of the Anna hummingbird in winter. Condor, 47: 79–80.
1945*b*. A distributional survey of the birds of Sonora, Mexico. Occas. Papers Mus. Zoöl. Louisiana State Univ. No. 21: 1–379, 26 maps.
1946. Two new races of birds from the lower Colorado River valley. Condor, 48: 80–82.

WEAVER, J. E., and CLEMENTS, F. E.
1938. Plant ecology (New York: McGraw-Hill Book Co.), xxii + 601 pp., 271 figs. in text.

SPECIATION IN SALAMANDERS OF THE PLETHODONTID GENUS ENSATINA

BY

ROBERT C. STEBBINS

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY AND LOS ANGELES
1949

University of California Publications in Zoölogy
Editors (Berkeley): Harold Kirby, R. M. Eakin, A. H. Miller

Volume 48, No. 6, pp. 377–526, plates 11–16, 16 figures in text

Submitted by editors December 18, 1947
Issued May 20, 1949
Price, $2.50

University of California Press
Berkeley and Los Angeles
California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

ACKNOWLEDGMENTS

I AM GRATEFUL to the following individuals and institutions for gifts or the loan of specimens: Sherman C. Bishop, College of Arts and Science, University of Rochester; Charles M. Bogert, American Museum of Natural History; Doris Cochran, Smithsonian Institution, United States National Museum; Helen T. Gaige and Norman Hartweg, University of Michigan Museum of Zoölogy; Howard K. Gloyd, Chicago Academy of Sciences; Margaret C. Irwin, Santa Barbara Natural History Museum; Laurence M. Klauber, San Diego Society of Natural History; Los Angeles Museum; George S. Myers, Stanford University Natural History Museum; Graham Netting, Carnegie Museum; Charles A. Reed; Karl P. Schmidt, Chicago Natural History Museum; Joseph R. Slevin, California Academy of Sciences; Joseph Slipp; Tracy I. Storer; and Alex Walker.

I wish to thank the persons who have aided in the collection of specimens: Paul Baldwin, John Davis, Wade Fox, Carl Koford, Charles H. Lowe, Jr., Alden H. Miller, Harold C. Reynolds, Mr. and Mrs. Thane Riney, Thomas L. Rodgers, Ward C. Russell, Lee Talbot, my father Cyril A. Stebbins, and brothers Hubert and Ernest.

Mr. Joseph Slevin kindly contributed the photograph of Fort Tejon and personal field notes.

Special mention should be made of the coöperation of Dr. Ernesto Cusi of the Madrid Museum for his part in determining the identity of the Plata *Ensatina* and also for the use of an excellent photograph of the type.

I wish also to extend thanks to Mr. H. W. Parker and others of the British Museum of Natural History who generously supplied photographs and information regarding the types of *Ensatina eschscholtzii*.

Others who in one way or another have contributed to the present paper are: Raymond B. Cowles, Emmett R. Dunn, Edmund C. Jaeger, Herbert L. Mason, Ian T. McCowan, Sherwin F. Wood, and Wallace F. Wood.

R.C.S.

CONTENTS

SPECIATION IN SALAMANDERS OF THE PLETHODONTID GENUS ENSATINA

(*With illustrations by the author*)

BY

ROBERT C. STEBBINS

(A contribution from the Museum of Vertebrate Zoölogy of the University of California)

INTRODUCTION

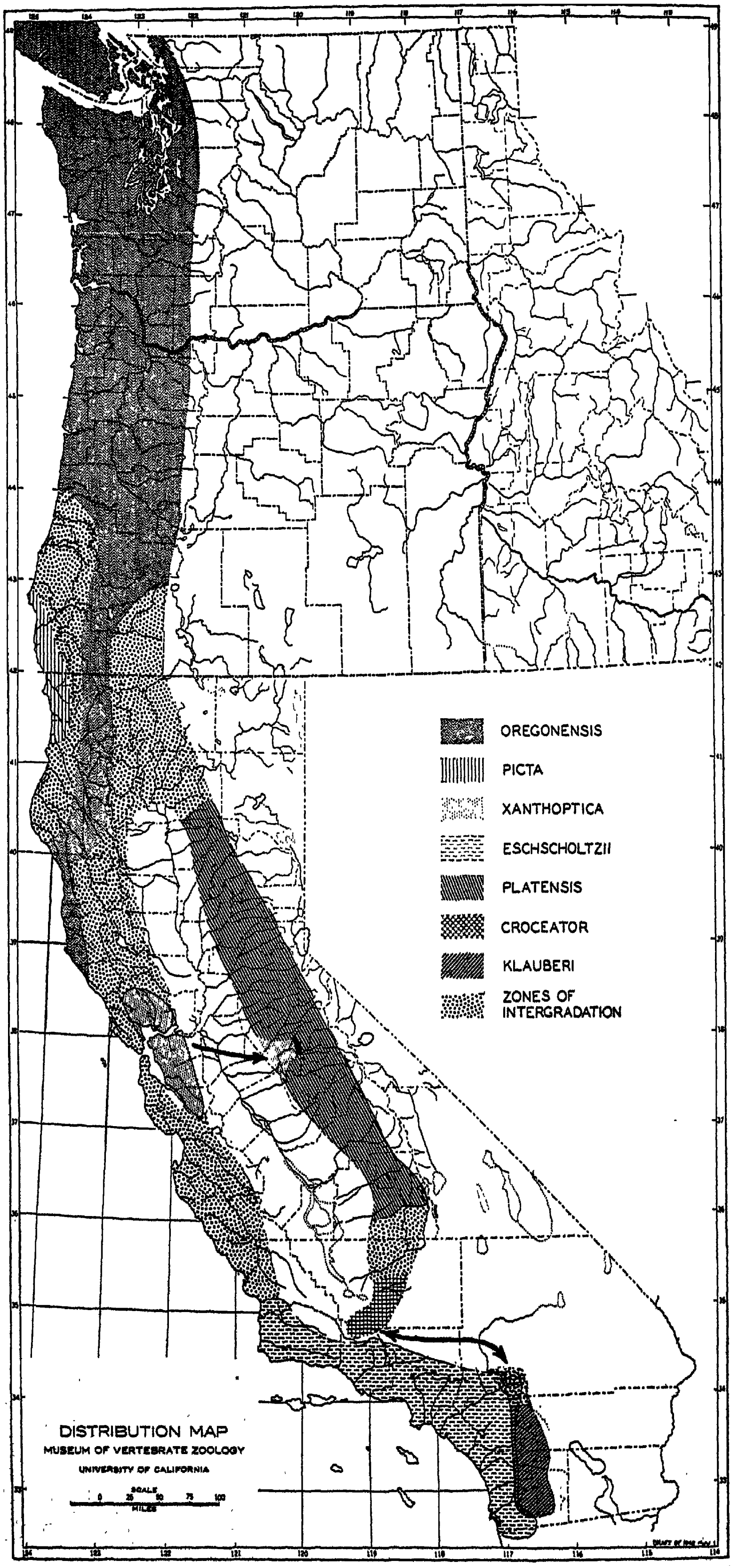
MAJOR OUTLINES of the processes of organic evolution seem now to have largely been set forth. We are entering a phase of investigation called by Huxley (1942) the study of comparative evolution. It is clear that one type of evolution is not common to all living things but rather there are many kinds requiring thorough study of many organic types.

This consideration has influenced the character of my investigation of the genus *Ensatina*. In the present paper, largely descriptive, I present an analysis of variation in external characters and attempt to interpret this variability. Rather as a by-product than as an end in itself, a revision of the systematics of the genus is presented. A second, and ever an accompanying phase of the work, has been the study of the ecology of the group. The results of this are to appear in a subsequent report. Only those aspects of ecology which bear on problems of variation and distribution are included at this time.

The genus *Ensatina* belongs to the family Plethodontidae. This family contains by far the largest number of species and is considered the most recently evolved group of urodeles. Its center of origin is thought to have been the Appalachian region of eastern North America (Dunn, 1926 : 11 and 12). From there plethodontids radiated outward, reaching Europe and South America.

The members of the family show varying degrees of adaptation to terrestrial life. *Leurognathus,* for example, is almost wholly aquatic, dwelling in mountain brooks. Others, such as *Pseudotriton* and *Gyrinophilus,* are intermediate in aquatic requirements. Many are terrestrial. This is true of a number of eastern genera and those in western North America and Central and South America. Strictly terrestrial forms have no aquatic larval stage. Metamorphosis occurs within the egg and the young emerge fully formed. *Ensatina* is such a terrestrial type.

A constant structural peculiarity in the family is the absence of lungs. Respiration is performed through dermal capillaries that lie beneath a thin moist integument, supplemented by buccopharyngeal respiration. The lungs of many salamanders seem to be primarily hydrostatic in function. Their loss in plethodontids has been correlated with the mountain brook ancestry of the family : the buoyancy resulting from the presence of these organs presumably


OREGONENSIS
PICTA
XANTHOPTICA
ESCHSCHOLTZII
PLATENSIS
CROCEATOR
KLAUBERI
ZONES OF INTERGRADATION
DISTRIBUTION MAP
MUSEUM OF VERTEBRATE ZOOLOGY
UNIVERSITY OF CALIFORNIA
SCALE
0 25 50 75 100
MILES

interfered with the activity of the animals in moving water, and effective bottom locomotion was facilitated by lung reduction. An alternative, or complementary, view holds that the high oxygen content of the cold, turbulent water of mountain streams fostered "degeneration" of these organs through lack of use, their function being replaced by dermal and buccopharyngeal respiration; other unrelated urodele groups show similar lung reduction in stream-dwelling types, probably for similar reasons.

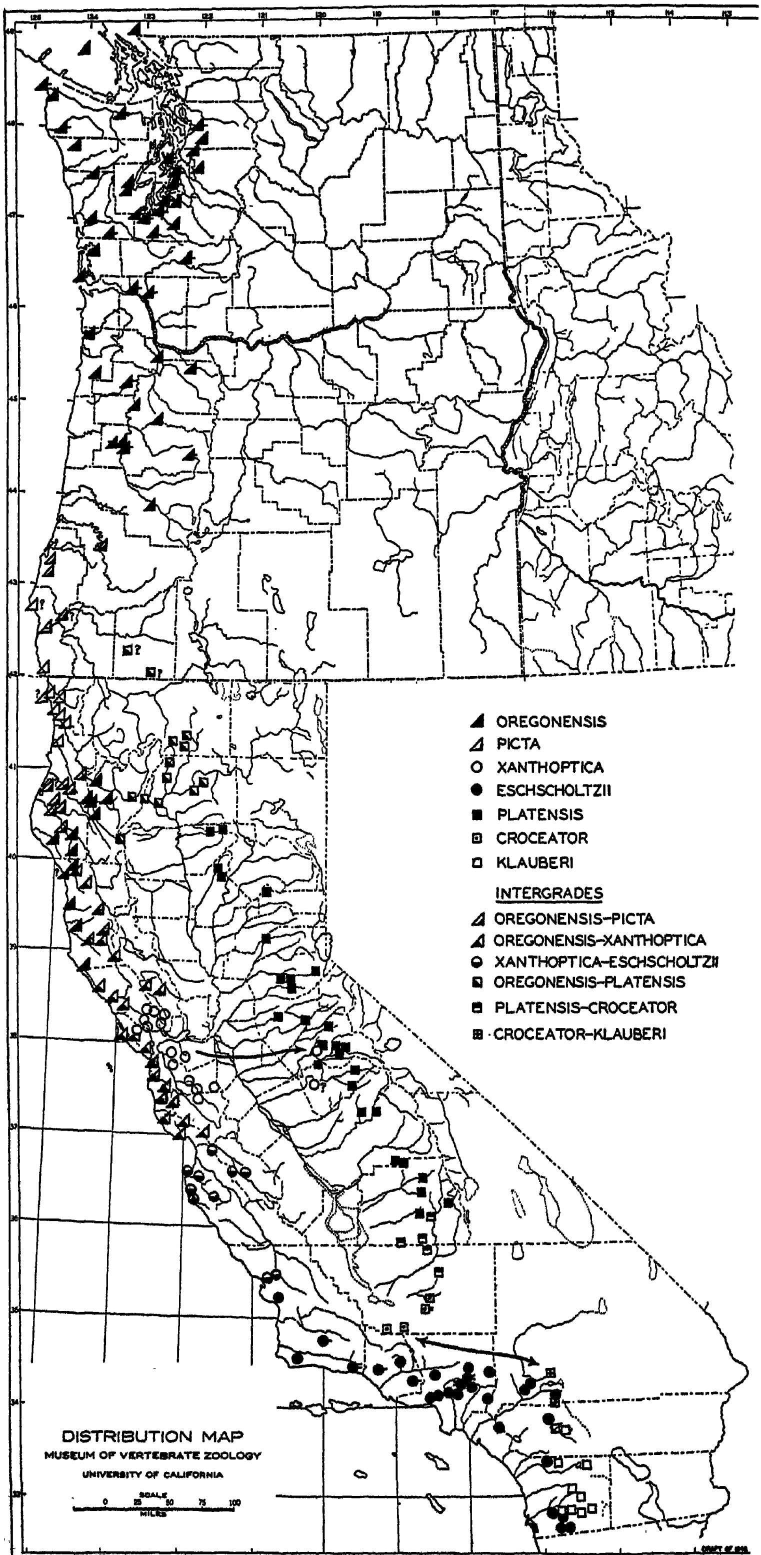
Another anatomical feature, of universal occurrence in the family, is the presence of a groove that runs from the nostril to the edge of the upper lip. This furrow, the nasolabial groove, is thought by Whipple (1906) to function in draining excess fluid from the nostril, thereby facilitating buccopharyngeal respiration and possibly olfaction.

Applying Jordan's Rule which, of course, is not without exception, we may look for the closest relative of the genus *Ensatina* among west coast plethodontids. The following genera are present: *Batrachoseps, Plethopsis, Aneides, Hydromantes,* and *Plethodon*. Of these, *Plethodon* appears to be the most generalized. The others show various specializations: *Hydromantes* in its high mountain habitat, depressed form, webbed toes, and tail structure and action; *Batrachoseps* and *Plethopsis* in their elongate form, reduced limbs and abbreviated toes; and *Aneides* in its enlarged premaxillary teeth and arboreal adaptations of dilated digits and prehensile tail. *Plethodon* lacks any such obvious specializations. It is a widespread genus with many representatives, which suggests evolutionary plasticity. It may be close to the ancestral type, if not actually the type from which the other genera, including *Ensatina,* were derived.

Although *Ensatina* shows no great specializations in structure, it exhibits some advances over *Plethodon*. The tail is constricted at its base, a provision for autotomy, and it possesses hypertrophied poison glands, which in conjunction with an inherent pattern of behavior, increases the effectiveness of the tail in combating an enemy. Although *Plethodon* has caudal poison glands, they are not as enlarged and the tail has no predetermined zone of disjunction. To my knowledge, no member of the genus assumes a defensive pose like that of *Ensatina.*

Ensatina appears to be a west coast offshoot of *Plethodon* or a *Plethodon*-like ancestor. As shown in this paper, so far as is now known, it is monotypic, represented by a single adaptable, widespread species, its range exceeding that of any other plethodontid of western North America. Its high degree of differentiation into color races and the diversity of its habitat, indicate that it is a plastic type. It appears to be a genus in the process of speciation.

Facing. Fig. 1. Distribution of the subspecies of *Ensatina eschscholtzii.* Intergradation between *platensis* and *xanthoptica* in the inner coast range north of Clear Lake in California is presumed on the basis of trends in characters. No specimens are available from this area. The change from *oregonensis* to *picta* involves the retention, in increasingly larger individuals, of the juvenal characteristics of dark blotching and large eyes. Because of lack of specimens and the gradual nature of the change, complicated by age differences, the exact limits of intergradation are uncertain. The dark area between the ranges of *platensis* and *xanthoptica,* in the Sierra Nevada, represents a zone of secondary contact between these two forms where some interbreeding (hybridization) occurs.



OREGONENSIS
PICTA
XANTHOPTICA
ESCHSCHOLTZII
PLATENSIS
CROCEATOR
KLAUBERI
INTERGRADES
OREGONENSIS-PICTA
OREGONENSIS-XANTHOPTICA
XANTHOPTICA-ESCHSCHOLTZII
OREGONENSIS-PLATENSIS
PLATENSIS-CROCEATOR
CROCEATOR-KLAUBERI
DISTRIBUTION MAP
MUSEUM OF VERTEBRATE ZOOLOGY
UNIVERSITY OF CALIFORNIA
SCALE
0 25 50 75 100
MILES

CHARACTERIZATION

Structure.—Adults approximately 90 to 150 mm. in total length; limbs well developed with four toes on fore and five on hind foot; palmar tubercles present; toes overlap 3½ to 4 costal folds when limbs appressed to sides; tail rounded above, slightly compressed below, constricted basally, just behind posterior margin of vent, tapering gradually distally; twelve costal grooves (rarely 11 or 13), counting one each in axilla and groin; head with sides parallel as viewed from above; snout rounded or truncate; gular fold present; eyes relatively large and protuberant, projecting well above dorsal surface of head, but readily retractable; pupil horizontally oval; tongue rounded or oval, pedicelled, attached anteriorly to floor of mouth by narrow strand of tissue with anterior border projecting somewhat beyond this connection; vomerine teeth in two transverse arcs, one on either side, curving anteriorly, approaching and rarely joining one another in midline, and extending behind and somewhat laterally to choanae; parasphenoid teeth arranged in two oval patches between eyes, convergent but rarely connected anteriorly; skin smooth, minutely pitted by openings of mucous and granular (poison) glands; poison glands greatly developed in skin of tail and head; present also on dorsal surface of body although production of milky secretion less copious there.

Coloration.—The great diversity in color and pattern in the genus can be resolved essentially into differences in the relative numbers and distribution of three types of pigment cells—the melanophores, lipophores, and guanophores (also called leucophores or iridiocytes depending upon the configuration of the guanin particles). These cells when isolated resemble one another in possessing many slender dendritic processes that radiate out from a central reservoir. Their content, however, differs. The melanophores contain particles of dark brown to black pigment; the lipophores carry a fatty substance that appears orange or yellowish; and the guanophores are filled with crystals of uric acid (guanin), appearing white, silvery, or pale blue. Brown to black, white, various shades of red, orange, and yellow are colors that are directly referable to these cell types. Yellow appears in the iris, dorsal pattern, and proximal segments of the limbs of some races. Sometimes this color is due to a combination of guanophores overlaid by lipophores. This has been noted on the dorsal surface of the proximal segments of the limbs. In places where an iridiocyte is only partly overlaid by a lipophore, yellow appears at the overlap.

The branches of the melanophores surround the dermal capillaries and radiate outward toward the openings of the skin glands. The blood vessels appear outlined with dark brown and the glandular openings are circled with dusky color. In dark animals the relationship is obscured by heavy pigment.

Facing. Fig. 2. Locality records for subspecies of *Ensatina eschscholtzii.* Symbols with two small bars appended are sight records; those with a single bar represent localities reported in the literature or museum records reported in correspondence. I cannot vouch for the accuracy of the latter. All others are based on material examined by me. Where question marks appear, the affinity of the animals is uncertain.

The pigment of the melanophores can be shifted from the branches to the central reservoir of these cells. When this occurs, the skin becomes lighter, and, in the lightest race, *eschscholtzii*, the melanophores may appear as black spots, without processes. Such movement of pigment has not been observed in the lipophores or guanophores. The capacity for darkening and lightening the skin, along with the relationship between the melanophores and the dermal capillaries, suggest a role in thermoregulation—of which more will be said later.

The lipophores also have their branches arranged around the skin capillaries. Such a close relationship, however, does not seem to occur between the guanophores and the blood vessels.

The arrangement and distribution of the pigment cells varies greatly. This variability is the principal topic of later pages, but a few generalizations, applicable to the genus as a whole, may be made here. Melanophores are extensive on the dorsal surface of the head, body, tail, and distal segments of the limbs. They may form a weak to heavy, unbroken network, or the network may be disrupted to form more or less well-defined spots or blotches. These gaps in the melanic ground may entirely lack melanophores or a scattering of them may be present. Melanophores are usually reduced on the toe joints, the toes appearing crossbanded with dusky in varying intensity. Melanophores may be lacking on ventral surfaces or may be present in varying numbers, sometimes in sufficient abundance to form a somewhat broken network—but one always less well defined than the dorsal reticulum. Melanophores may or may not be present in the lining of the body cavity, paralleling in arrangement those ventrally situated.

Lipophores, in close association with melanophores, are of variable occurrence dorsally. Where breaks in the melanic ground color occur, lipophores are present, producing the cream, yellow, or orange of the dorsal spots or blotches. The color of the markings is sometimes modified by associated guanophores. Lipophores are present on the proximal segments of the limbs where melanophores are usually reduced or absent. The area of reduced melanism usually includes half to all of the limb segments. The ventral surfaces may lack lipophores; they may be present in varying numbers; or they may form a uniform network covering all underparts.

Guanophores may be absent dorsally or they may be present in varying numbers. They are often irregularly distributed. Sometimes they are present in sufficient abundance to form a hoary suffusion. They are scarce ventrally. They may form a patch of light color in the upper iris and sometimes a smaller marking in the lower iris. The iridic patches are variable in size and definition and they may be wholly lacking. There is usually an irregular guanophore network dorsally at the base of the limbs beneath the lipophores. It is possible that there is close association here between these pigment cell types to form xantholeucosomes as described by Parker (1948).

SPECIES CURRENTLY RECOGNIZED

As currently classified, the genus is divided into four species, all of which occur in the western hemisphere, 3 of them in western North America and the other at the mouth of the Plata River in South America. One is polytypic. These species with their ranges are (pls. 11 and 12):

1. *Ensatina eschscholtzii* Gray (pl. 11, figs. 1 to 4).—A dark-blotched or uniformly brown or reddish brown salamander with yellowish or orange proximal segments of the limbs and with light-colored venter. *Range.*—Pacific Coast of North America, in the coastal mountains from Vancouver Island and the adjacent mainland in British Columbia to San Diego County in southern California.

2. *E. sierrae* Storer (pl. 12, fig. 16).—A dark brown salamander with reddish orange spots and with the proximal segments of the limbs and venter as in *eschscholtzii*. *Range.*—California in the southern Cascade Mountains and the Sierra Nevada.

3. *E. croceator* (Cope) (pl. 12, fig. 20).—A black salamander with large, often rectilinear, reddish orange markings; proximal segments of limbs orange; ventral surfaces dusky. *Range.*—Southern California in the higher mountains of San Diego County, north into the San Bernardino Mountains and thence west to Fort Tejon.

4. *E. platensis* (Espada).—A salamander closely resembling *sierrae* in structure and markings. Colors in life not known. *Range.*—Known only from the type locality, Montevideo (?), Uruguay, and from the vicinity of Buenos Aires, Argentina.

Dark-blotched animals from a narrow coastal strip in northern California and southern Oregon have been recognized as a subspecies of *E. eschscholtzii* by Wood (1940). This population, *E. e. picta* (pl. 11, fig. 4), is surrounded, except where it borders on the coast, by the more widespread unspotted *E. e. eschscholtzii.*

NOMENCLATURAL HISTORY

Gray (1850: 48) first applied the name *Ensatina eschscholtzii* to specimens in the British Museum. Oddly, the accompanying description seems to be of *Triton* (=*Dicamptodon*) *ensatus* and this name is given, "*Triton ensatus,* Eschscholtz," along with a reference to the original account. Three animals are mentioned—"a, b, c. In spirits. California. Half-grown and young."

The apparent confusion between *Dicamptodon* and *Ensatina* in Gray's mind led to the adoption of the name, *Heredia oregonensis,* proposed by Girard (1856: 140–141). This name was based on a specimen collected in Oregon by the United States Exploring Expedition under Commander Wilkes, U.S.N.

Later, St. George Mivart informed Cope that *Ensatina* Gray was identical with *Heredia* Girard. Cope (1867: 167) states: "If this be the case, it is established on a species of the Plethodontidae, and one not to be separated from Plethodon. I therefore call *H. oregonensis* Girard, *Plethodon ensatus* . . ." Cope (1869: 100) corrected the name to *Plethodon oregonensis* when Mivart pointed

out that the specific name *ensatus* was not correct, Cope's error having resulted from the confusing nature of the original description.

Cope (1867: 211) also described *Plethodon* (=*Ensatina*) *croceator,* based upon a specimen collected by John Xantus, presumably at Fort Tejon, California. In later years, a question arose regarding the validity of the type locality since additional specimens were not found. Slevin (1930), however, reported on a specimen taken at the Fort by E. Van Dyke that tended to confirm the type locality. Recently, the author and others have obtained near the Fort additional examples of *Ensatina* that fit Cope's description.

Boulenger (1882: 54–55) characterized material from Oregon, along with Gray's type specimens, under the name *Plethodon oregonensis.* The description clearly applies to salamanders now recognized as *Ensatina.* That Boulenger had the types of *Ensatina eschscholtzii* is supported by his reference to them as "a–c. ♀ & yg.", indicative of the series mentioned by Gray. He gives the type locality as "Monterey" without comment on the greater specificity of his allocation.

Jiménez de la Espada (1875) described a light-blotched plethodontid from South America, *Urotropis platensis.* The description was based on a single specimen, of which the locality of collection was not known but was thought to have been in the vicinity of Montevideo, Uruguay. Dunn (1923*a*: 39–40), following a study of the family Plethodontidae, placed the species *eschscholtzii* and *croceator* in the genus *Ensatina,* separating them from *Plethodon.* He also included *platensis,* removing it from *Urotropis.*

Dunn (1929) described an orange-blotched salamander from Descanso, San Diego County, California, as a new species, *Ensatina klauberi.* Storer (1929), upon studying Cope's description of the Fort Tejon specimen, decided its affinity was with Dunn's blotched form from southern California. Since the name *croceator* had also been applied to *Ensatina* from the Sierra Nevada of California this left the Sierran type without a name. He designated it as *E. sierrae* and reduced Dunn's *klauberi* to a synonym of *croceator.*

Slevin (1930) considered the Van Dyke specimen from Fort Tejon as intermediate in its markings between the Sierran form and that of the southern mountain ranges. He believed the Sierran type in turn might intergrade with *E. eschscholtzii* of the coast, on the basis of 3 specimens from Tehama County, California, that had reduced spots in the head region. He suggested that the three forms, *croceator, sierrae,* and *eschscholtzii,* be considered members of a single species which he called *croceator,* not recognizing the priority of *eschscholtzii.*

Storer (1929) called attention to the mottled coloration of *eschscholtzii* from northern California and southern Oregon and Wood (1940) described this population as the race *picta.*

Recently Myers and Carvalho (1945) have doubted the validity of the type locality of *E. platensis* and have presented arguments for the belief that the Plata *Ensatina* was based on a specimen from the Sierra Nevada of California.

PROPOSED SYSTEMATICS

The ranges of the North American forms, *eschscholtzii, croceator,* and *sierrae* replace each other geographically. This fact, along with their great structural similarity, suggested that they might be color races of a single species exhibiting, like *Ambystoma tigrinum* (Dunn, 1940), great color variation while their proportions tended to remain stable. The most obvious structural differences among them were the distribution and relative numbers of the pigment cells that formed the color pattern, namely, the melanophores, lipophores, and guanophores.

The gaps separating their ranges were not great. In view of the presence of suitable habitats in these areas, it seemed plausible that the breaks in range might be gaps in collecting and not actual discontinuity in distribution. The Sierra Nevada, the habitat of *sierrae,* is connected with the Coast Ranges through the Siskiyou Mountains in northern California. Thus a connection between *sierrae* and *eschscholtzii* seemed possible. Likewise, to the south, the Sierra Nevada is connected with the Mount Pinos area and Fort Tejon, at the northern part of the range of *croceator,* making a juncture with this form also possible. It appeared that the genus in California might be represented by a single species composed of allopatric subspecies.[1]

Field work in the two critical areas, the Siskiyou Mountains and the Tehachapi Mountains, has yielded ensatinas. The animals procured in these "gap" areas bridge the differences in color and pattern between the forms now recognized as species. Since intergrades are present, the natural relationships can better be expressed by treating them as subspecies. We have then, as anticipated, a polytypic species, consisting of a series of sharply defined color races or subspecies. In California these races are distributed in mountainous areas roughly in the form of a ring, kept open by the inability of the animals to establish themselves in the Lower Sonoran conditions prevailing in the Great Valley. The extreme races at the southern side of the ring overlap geographically but apparently do not interbreed. Seemingly, here they came together after differentiation to a point sufficient to prevent interbreeding. These end points have reached the species level in their interrelation.

The changes in nomenclature adopted in this paper are then as follows: The genus is viewed as monotypic, consisting of the species *eschscholtzii* comprised of seven races. I reduce *sierrae* to subspecific status and change the name to *platensis.* The Plata *Ensatina* of Espada is evidently based on a specimen from the Sierra Nevada of California (p. 448). The name *"klauberi,"* proposed by Dunn (1929), is revived and embraces the orange-blotched *Ensatina* south of San Gorgonio Pass in southern California. *Croceator* is restricted to a yellow-blotched population in the Tehachapi Mountains that is

[1] As mentioned earlier, Slevin (1930), had proposed such a view. In conversation with Dr. G. S. Myers and Mr. Thomas Rodgers, I learned that they likewise had considered the possibility of the three species in California being races of a single species. Since my talk with Dr. Myers, the paper by him and Carvalho (1945) on the Plata *Ensatina*—then in press—has appeared, expressing this view. Dunn (1926) suspected intergradation between *croceator* (=*sierrae*) and *eschscholtzii* in northern California. Storer, (1929:450), also considered this possibility, but lacked the specimens required to settle the matter.

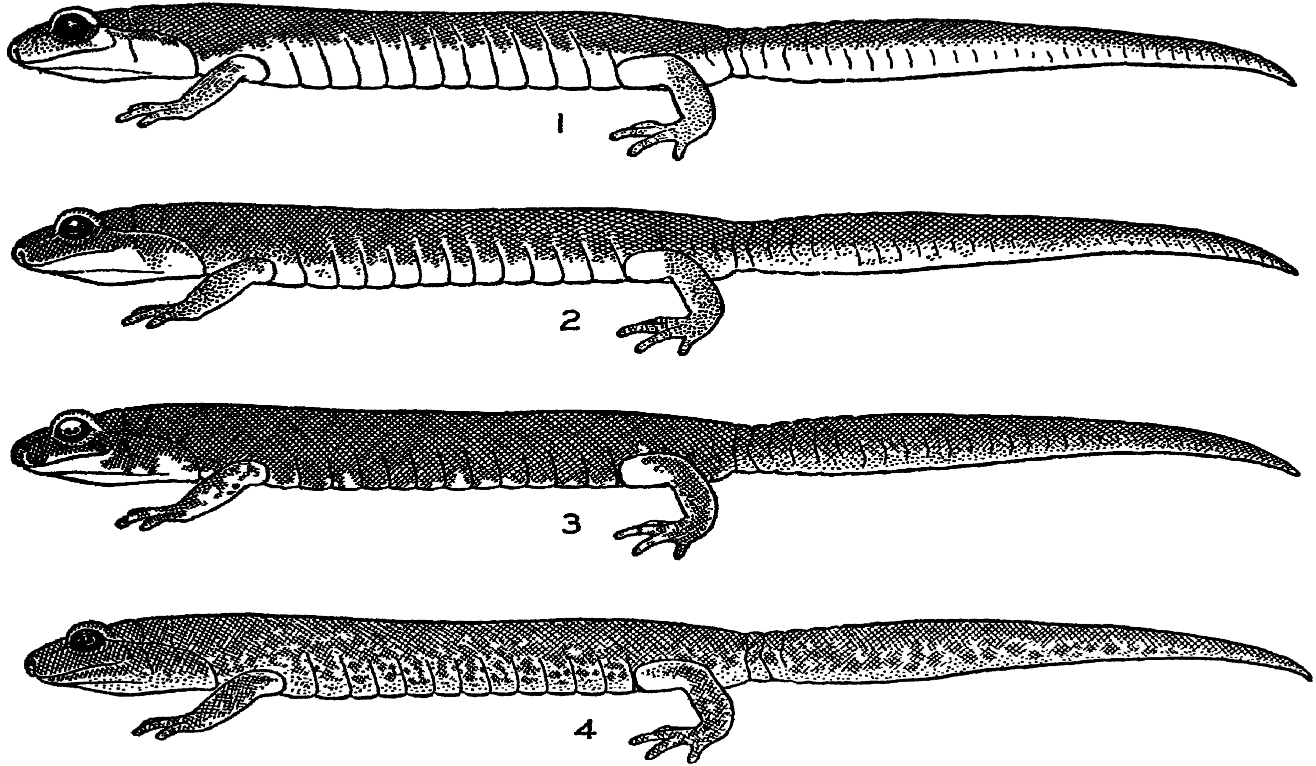


Fig. 3. Standards for melanophore development on the sides of the body: (1) melanophores above a line connecting the upper bases of the limbs; (2) even with the limb line; (3) below the limb line; (4) mottled style of coloration found in most individuals of *oregonensis* and in some other populations.

The specimens from which the drawings were made and their localities of collection are: (1) MVZ 44043, 8.5 mi. SE Lompoc, Santa Barbara County, California; (2) MVZ 27767, 1 mi. NW Big Sur, Monterey County, California; (3) MVZ 33305, Las Trampas Creek, Contra Costa County, California; (4) MVZ 43814, Wheeler, Tillamook County, Oregon.

intermediate in pattern between *klauberi* and *platensis* but shows a constant difference in this pattern and in coloration. Two additional races of *eschscholtzii*, within the range of the form now known by that name, are described—*xanthoptica* and *oregonensis*.

CHARACTERS STUDIED AND METHODS OF ANALYSIS

PIGMENTATION

Color analysis, an important part of studies of geographic variation in birds and mammals, is sharply limited in poikilothermous vertebrates. With present methods of preservation many colors are lost. In amphibians there are further restrictions, for these animals lack scales, so useful in work on reptiles and fishes. In the absence of living or freshly preserved animals, one is obliged to rely to a large extent on comparisons of size, proportions, tooth counts and arrangement, and, in salamanders, on counts of costal grooves. Fortunately, the melanic pigments are little affected by preservation. The lipophores and guanophores, however, fade rapidly and after a time, may no longer be discernible.

In the present study, I have treated most exhaustively the subject of the distribution and arrangement of the melanophores. However, through field work and color analyses of living individuals, it has been possible to trace variation in the lipophores and guanophores nearly as completely.

Two ways of approaching the problem of color variation present themselves: (1) the analysis of the distribution and arrangement of pigment cells and (2) the study of gross color effects. In the latter approach, I refer to colors produced by the mass effect of a pigment cell type or several types acting in combination or influenced by structural factors. The analysis of color is fraught with subjectivity. In order to provide as much objectivity as possible, the first approach has been implemented by comparison of each animal with individuals established as standards for pigmentary characters; the second by the use of Ridgway's (1912) color key. Color determinations were made under uniform lighting. All capitalized colors appearing in subsequent pages are from Ridgway. A single copy was used to avoid variations among copies of this volume due to fading, wear, and differences in preparation.

Variation with age was shown roughly by classifying individuals as juvenile, subadult, and adult, basing determinations on size and the degree of development of secondary sexual characteristics. A check on possible sexual variation in adults was readily made since external structural dimorphism is present (p. 478).

DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Head and body.—Individuals are compared as to density of melanin. An attempt is made to classify them according to the depth of the dorsal ground color of the head and body, irrespective of the presence of light marks as found in the interior blotched races. Further, the degree of continuity of the melanic network is noted and the degree of uniformity in dispersion of pigment.

Tail.—Because of a tendency for the tail to have markings and because of peculiarities in coloration appearing with regeneration in the coastal unicolored races, its coloration usually is analyzed separately. In the interior blotched races, except for occasional regenerates, the tail resembles the body and is not given separate consideration.

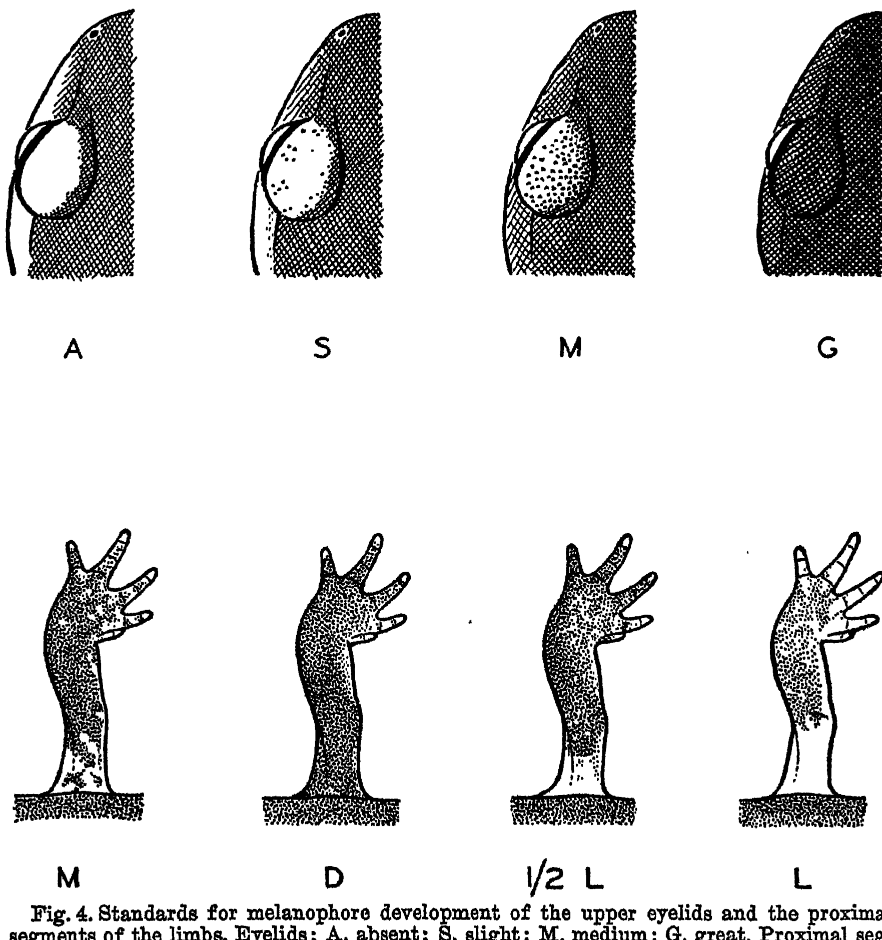


Fig. 4. Standards for melanophore development of the upper eyelids and the proximal segments of the limbs. Eyelids: A, absent; S, slight; M, medium; G, great. Proximal segments of limbs: M, mottled; D, all dark; ½ L, half light colored; L, entirely light colored.

Sides.—The extent to which melanophores appear on the sides of the body is shown by relating the edge of the melanic pigmentation to a line connecting the upper bases of the limbs (text fig. 3). The melanophores of the sides are said to be above, even with, or below the limb line. The irregularity of this melanic margin and the tendency for it to slope slightly upward from the hind limb, makes precise segregation difficult. Intermediate categories are provided for individuals of uncertain affinity.

Upper eyelids.—In the coastal races, the amount of melanophore development of the upper eyelids is indicated by four categories (see fig. 4): absent (A), slight (S), medium (M), and great (G). The interior races have a dark

melanic ground color with or without light spots. The presence or absence of markings on the lids is indicated.

Limbs.—Individuals are classed in four groups according to melanophore development of the proximal segments of the limbs (text fig. 4): all light colored (L), ½ light colored (½ L), all dark (D). In addition, the presence or absence of mottling (M) is noted. Intermediate categories again are provided for individuals of uncertain affinity.

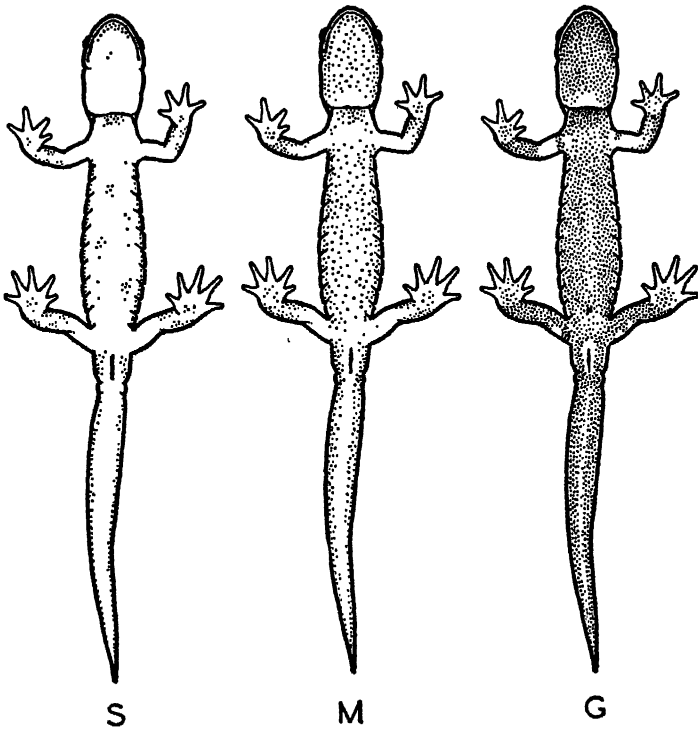


Fig. 5. Standards for melanophore development of the ventral surfaces of the body. S, slight; M, medium; G, great.

Ventral surfaces.—The method of analysis has been first to classify individuals in four categories indicating abundance of melanophores (text fig. 5): melanophores absent (A), scarce (S), medium (M), and great (G). Secondly, to plot the detailed distribution of melanophores by noting their presence or absence in various areas of the ventral surface, such as the chin, gular area, postgular area, pectoral region, abdomen, pelvis, vent, and tail. Examinations were made under a dissecting microscope to determine the relative number and position of cells. The general coloration of the ventral surfaces varies with their state of contraction, hence such coloration is a less reliable criterion in segregation.

Pleuroperitoneum.—A sprinkling of melanophores occurs in the lining of the body cavity in some races. These cells are indicated as being present or absent. No attempt was made to measure their abundance.

LIPOPHORES

An analysis is made of the lipophores of the ventral surfaces. In color descriptions of living animals, they have been indicated as (1) forming a continuous network, (2) as being variously disrupted on the throat and body, (3) as absent except for the tail and limbs, and (4) as wholly lacking.

Trends in the coloration of lipophores are observed in the color of the proximal segments of the limbs, sides of the body, ventral surfaces, and, in the interior blotched races, the color of the dorsal markings.

GUANOPHORES

Details in the distribution of guanophores of the skin and iris were noted in living animals. In studying iridic guanophores, a drawing was made of the right eye of each animal collected, showing the position, size, shape, and density of the markings formed by the guanophores (text fig. 6). In most instances, the diagram was prepared with the aid of a dissecting microscope. Color of the iris patch was also recorded. To minimize differences due to varying incidence of light, each subject was held in the same position under uniform lighting.

The chromatophores that form the light iris patches have not been identified with certainty but will be referred to in this paper as guanophores.

PATTERN

The coastal race *picta* and the interior races *platensis, croceator,* and *klauberi* have markings on the dorsal surface of the body. Standards were established to determine the nature of variation in these markings.

Picta, immature *oregonensis,* and intergrades between *oregonensis* and *xanthoptica* have varied development of dorsal dark blotches. Blotching of individuals was classified (text fig. 7) as: absent (A), medium (M), and great (G).

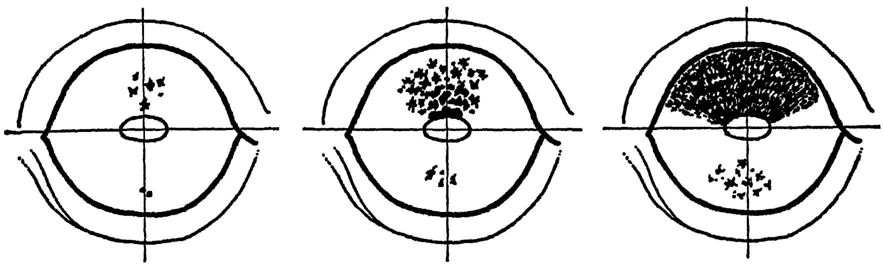
The interior races are blotched in varying degrees with orange, cream, or yellow markings. These spots gradually increase in size and regularity of outline to the south. A graded series of pattern types was selected to which individuals were referred (pl. 13, p. 519).

For all pattern determinations direct comparison was made with specific individuals chosen as standards.

OTHER CHARACTERS

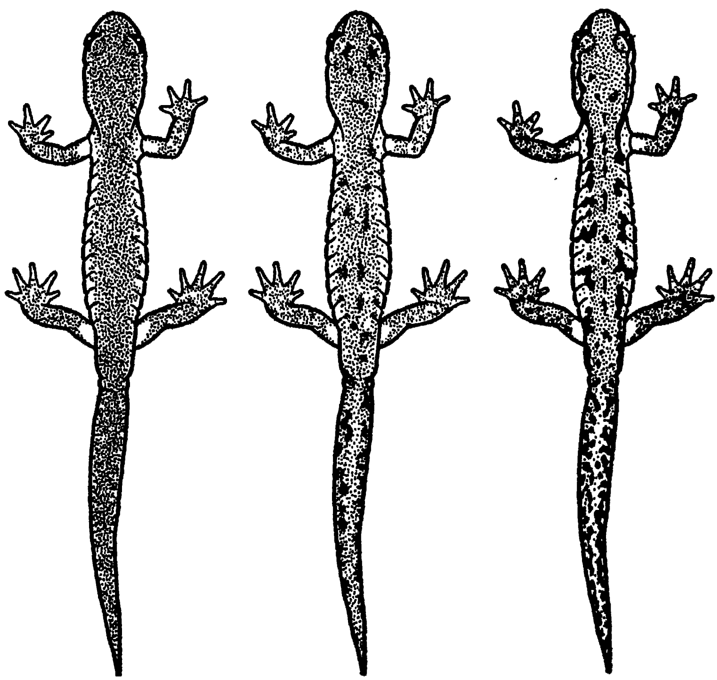
In view of the well-marked and constant color differences present, it seemed likely that other variables would appear that would be useful in segregating the animals. Such characters not only would have practical value in identification of preserved specimens, particularly among the unspotted coastal races, but, of greater importance, they would perhaps aid in deducing evolutionary trends and relationships and in interpreting certain aspects of the natural history of the species.

In studying numerous living animals over a wide geographic range, it ap-



2 3 4

Fig. 6. Standards for guanophore development of the iris. 2, slight; 3, medium; and 4, great. Guanophores are shown in black. Type 1, lacking guanophores, is not shown.



A M G

Fig. 7. Standards for dark blotching. A, absent; M, medium; G, great. Specimens and their localities of collection are, respectively: MVZ 42061, Eastmoreland Golf Course, Portland, Multnomah County, Oregon; MVZ 12572, 3 mi. E Kneeland P. O., Humboldt County, California; and MVZ 29640, Klamath, Del Norte County, California.

peared that there were significant size differences as well as subtler deviations in proportions. To test these impressions, a series of individuals from each race was selected for study. Animals approaching maximum size were chosen to minimize variation due to age differences. Sexual variation was eliminated by using only males. Zones of intergradation, as based on known color trends, were avoided and an effort was made to obtain a scattered sampling from the geographic range of each race. All measurements were taken from preserved

specimens by means of dial calipers, calibrated to .1 mm. The smaller calculations were made with the aid of a dissecting microscope (12.5 × ocular and 10 × objective). The following determinations were made for each individual: *body length,* tip of the snout to the posterior margin of the vent; *tail length,* posterior margin of the vent to the tip of the tail (regenerated tails were avoided); *head-neck length,* snout to a line connecting the anterior bases of the forelimbs; *snout to gular fold; axilla to groin; fore-limb length,* axilla to the tip of the longest toe when the limb is straightened and held at a right angle to the longitudinal axis of the body; *hind-limb length,* groin to the tip of the longest toe; *anterior eye corner to eye corner,* distance between the anterior eye corners; *eye opening,* from posterior to anterior eye corner; *tooth counts,* the vomerine and parasphenoid teeth on the right side; *costal grooves,* including one each in axilla and groin.

Sexual dimorphism in adults is present. In the race *eschscholtzii,* a series of adult females is compared with a series of males, but other races have not been so studied.

MATERIAL

The present study is based on the examination of 1810 animals. Of this total, 740 were seen alive and, for the most part, were collected by the author. Over 300 individuals were released following examination. They were captured in connection with field studies of marked populations.

Animals available to me, apportioned among the races and their intergrading populations, are as follows: *picta* 230/36;[a] *oregonensis* 373/17; *oregonensis-xanthoptica* intergrades 352/96; *xanthoptica* 271/230; *xanthoptica-eschscholtzii* intergrades 131/18; *eschscholtzii* 203/165; *oregonensis-platensis* intergrades 44/39; *platensis* 120/36; *platensis-croceator* intergrades 13/9; *croceator* 15/13; *croceator-klauberi* intergrades 10/7; *klauberi* 48/5.

Not all of these animals were used in detailed analyses of characters but they were examined and a decision was made as to their affinities.

ACCOUNTS OF SUBSPECIES

To facilitate study and presentation, detailed analysis of variation in the species has been broken up into segments, consisting of the races and their intergrading areas. This, of course, has required delimiting populations. Fortunately, in most subspecies of *Ensatina* there is considerable uniformity in most chromatic characters studied. This, coupled with gaps in collecting, makes it convenient to consider deviates in peripheral areas as indicative of the beginning of intergradation. Lines delimiting zones of intergradation are, of course, essentially nomenclatural conveniences. A more accurate picture of character trends is given in Analysis and Summary (p. 477) following the accounts of subspecies. Here characters are traced individually and are followed throughout the range of the species.

Following each locality record in accounts of races is given the basis for the record, whether a reference, sight record, or specimen. The number of

[a] The numerator is the total number studied; the denominator those seen alive.

individuals examined by me is indicated after each locality, with the source of the material. When a fraction is used, the numerator is the total number of animals seen, the denominator, those of the total seen alive.

A section appears on habitat in the accounts of the interior blotched races and *eschscholtzii*. Individuals of these subspecies are obtained with more difficulty than representatives of the others and their habitats are less well known. More detailed analyses of habitat requirements are to be presented in a subsequent report.

ABBREVIATIONS USED IN SUBSPECIES ACCOUNTS

AMNH, American Museum of Natural History; CAS, California Academy of Sciences; CHAS, Chicago Academy of Sciences; CM, Carnegie Museum; CNHM, Chicago Natural History Museum; CPS, College of Puget Sound; LAM, Los Angeles Museum; LMK, Laurence M. Klauber; MVZ, Museum of Vertebrate Zoölogy; PB, Paul Baldwin; RBC, Raymond B. Cowles; RCS, Robert C. Stebbins; SCB, Sherman C. Bishop; SNHM, Stanford University Natural History Museum; SSNH, San Diego Society of Natural History; TIS, Tracy I. Storer; UMMZ, University of Michigan Museum of Zoölogy; USNM, United States National Museum; YM, Yosemite Museum, Yosemite National Park; b, snout-vent length; j, juvenile; s, subadult; js, juveniles and subadults not differentiated.

COASTAL SUBSPECIES

Ensatina eschscholtzii oregonensis (Girard)

Heredia oregonensis Girard, 1856: 140–141, original description.
Plethodon ensatus, Cope, 1867: 167, part.
Plethodon oregonensis, Cope, 1869: 100, part.
Ensatina croceator, Slevin, 1930: 78, part.

Type.—Dunn (1926) lists nos. 15479–80 in the United States National Museum from Puget Sound, Washington, as the "types" of *oregonensis*. Girard (1856) refers to his material as "collected in Oregon by the United States Exploring Expedition."

General description of adult.—Light to dark brown above, often uniformly colored, but sometimes minutely flecked with light color (in life, pale yellow to orange) due to irregular distribution of melanophores and lipophores; eyelids dark, like skin of head; sides usually mottled due to irregular distribution of lipophores and melanophores, with light-colored markings concentrated in costal grooves; light color along sides pale orange or yellowish orange; basal half or less of upper surface of proximal segments of limbs yellowish to yellowish orange; distal segments colored like upper surface of body, although usually somewhat lighter; feet light colored, particularly on toes, stippled with melanophores; ventral surfaces of limbs and tail usually light orange or yellowish due to presence of lipophores, but occasionally whitish; remaining ventral surfaces whitish or variously spotted and blotched with clusters of pale orange to yellowish lipophores; ventral surfaces with fine, usually evenly spaced, ventral stippling of melanophores; pleuroperi-

toneum similarly marked; guanophores usually present in considerable numbers along sides of neck and body, less common on sides of tail, although usually present basally; guanophores may be present dorsally in varying numbers but they are often scarce and sometimes are absent except for concentration at upper base of each limb, forming patch of irregular shape beneath lipophore network; iris with varying numbers of guanophores forming patch of whitish, yellowish, bronze, or copper in upper part and sometimes smaller patch in lower part; iridic guanophores sometimes absent.

Color changes with growth.—Juvenile resembles *picta* (pl. 11, figs. 4 and 14) in dark blotching of body and tail; ground color brown above, grading into reddish brown on tail; proximal segments of limbs yellowish to yellowish orange; distal segments like body, but somewhat lighter; below gray, resulting from closely set melanophores on whitish, lipophore-free or weakly marked venter; dorsal surfaces sprinkled with guanophores except for proximal segments of limbs where they are scarce or absent, except for patches at upper bases of limbs beneath lipophore network; guanophores usually heaviest on head, lightening posteriorly on body and on distal segments of limbs, sometimes sparingly present on ventral surfaces.

With growth, major changes are obscuring of juvenal blotching, reduction in conspicuousness of guanophores, lightening of ventral surfaces, and dulling of color of tail.

Diagnosis.—Distinguished from races *platensis, croceator*, and *klauberi* by absence of well-defined, light-colored (orange, yellow, or cream) spotting or blotching, much reduced light color on proximal segments of limbs, and common occurrence (except in northern part of range) of lipophores on throat, chest, and abdomen; from *picta* by absence of dorsal dark blotching (juveniles and subadults excepted); from *xanthoptica* by extensive and more uniformly distributed ventral melanophores, smaller eye patch, dark eyelids, mottled sides, much reduced light color on proximal segments of limbs, and less regular occurrence and smaller numbers of ventral lipophores; from *eschscholtzii* by presence of iridic guanophores (some exceptions), frequent presence of lipophores on throat, chest, and abdomen, common occurrence of guanophores in skin of adults, and features of melanophore distribution similar to those referred to in comparison with *xanthoptica*.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Head and body.—*Oregonensis* varies geographically in the color of the dorsal surfaces sufficiently so that recognition of a northern and southern race within the zone now considered as the range of this subspecies has been considered. Animals from the humid Transition Zone, in Mendocino and Humboldt counties, are dark brown to nearly black, whereas those from Oregon and Washington average considerably lighter. The dark southern population constitutes the darkest coastal *Ensatina* known to me, approaching, in ground color, the pigmentation of the interior spotted races of California, *platensis* and *croceator*, but it is not as black as *klauberi*. The color of the more northerly

animals, in Oregon and Washington, is exceeded considerably in depth by most *xanthoptica* but not by *eschscholtzii*. The general aspect of coloration in preserved specimens of *oregonensis* and *eschscholtzii* is quite similar.

Lighter individuals, particularly from Oregon, have a suggestion of salt and pepper style of pigmentation due to the presence of small breaks in the melanic ground color. This tendency becomes more pronounced as *picta* is approached. The condition is paralleled somewhat by some *eschscholtzii* from the southern part of its range (p. 421). *Xanthoptica* typically is colored uniformly.

In some individuals melanin is unevenly distributed, forming dark blotches, particularly dorsolaterally. This is true of all juveniles studied, to a lesser extent of subadults, and rarely of adults. As will be seen in text figure 8, one or more adults with some degree of dorsal mottling have been found at nearly every locality of collection. It appears certain that, given large series, mottling will be found to occur in varying degrees throughout the entire range of the race. Blotching also appears in animals from areas of intergradation with *xanthoptica*.

When blotches are present on the body, the tail is usually similarly marked, but unmottled animals may or may not have uniformly colored tails. Regenerated tails are often mottled. The arrangement of the markings, particularly of juveniles, is suggestive of the race *picta*.

To determine the distribution and frequency of dark-blotched animals, individuals were classified according to three pattern types (text fig. 7, p. 391). The area from which they come extends from Santa Clara County, south of San Francisco Bay, California, into Washington. *Xanthoptica,* at all sizes, with the exception of a single adult from Alum Rock Park, lacks dorsal mottling, hence this race was not included in the analysis.

Data presented in text figure 8 may be summarized as follows: As one proceeds northward through intergrading areas west and north of San Francisco Bay, an increasing number of individuals exhibit *picta*-like blotches. At first only an occasional juvenile may be found with such markings. Later the number of young with mottled coloration increases and occasional subadults, and rarely an adult, may be so marked. In Marin, Sonoma, and northern Napa counties, nearly all the young have *picta*-like markings. Farther north, more individuals are mottled with progressively larger animals displaying dark blotches. Near the northern boundary of Mendocino County, considerable numbers of adults are mottled, some of them almost *picta*-like in appearance. Farther north, along the coast, mottling becomes continually more apparent until it reaches its peak in the area occupied by *picta,* the range of which, as indicated by Wood (1940), extends from central Humboldt County through Del Norte County, California, to Curry County in southwestern Oregon. Here nearly all individuals are blotched. The greatest mottling occurs in Del Norte County. Strangely, animals from Castle Rock, about 3 miles off shore from an area occupied by a heavily blotched population (Mill Creek Park), have much reduced markings. Blotching becomes less pronounced northward through Oregon, beyond the range of *picta,* into Washington and British Columbia, at the northern limit of the range.

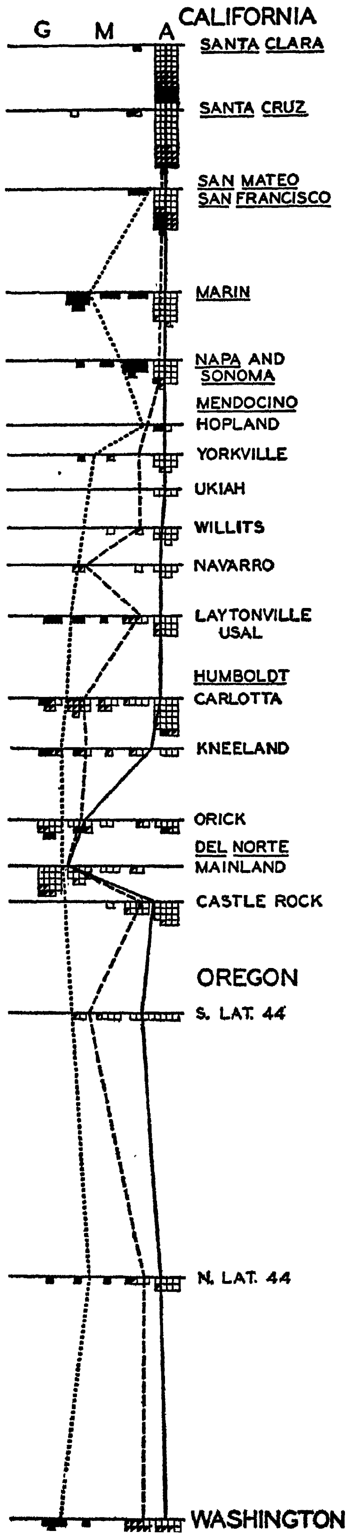


Fig. 8. Occurrence of dorsal dark blotching in coastal populations of *Ensatina eschscholtzii*, from Santa Clara County, California, to Washington. Standards for blotching are: A, absent; M, medium; and G, great (see fig. 7). Variation in juveniles is indicated by the solid squares and dotted line; subadults by bicolored symbols and a dashed line; adults by open squares and a continuous line. Underlined words are counties with, in some instances, localities following them. Horizontal lines representing states, counties, and smaller subdivisions are roughly spaced to scale geographically.

Similarly, blotching disappears as one proceeds interiorly from the coastal strip occupied by *picta*. For example, in California, along the Arcata-Weaverville Road (U. S. Highway 299) there is progressive fading of the markings, with rather typical *oregonensis* appearing near the western boundary of Trinity County at Burnt Ranch.

As to the size at which dorsal blotches are lost in regions far removed from *picta*, a series of 26 individuals (6j, 14s, 3 ♂, and 3 ♀) from Washington is suggestive. The bodies of all adults are unblotched, 9 subadults are faintly marked, and 6 juveniles have pronounced markings although less well defined than *picta*. All blotched animals are below 44 mm. in snout-vent length. Adults average 58 mm.

TABLE 1

MELANOPHORES OF UPPER EYELIDS IN E. E. OREGONENSIS

State	Between slight and medium	Medium	Great*	Mottled
Washington	....	....	6j†	....
	....	....	2s†	4s
	....	2♂	6♂	....
	....	1♀	5♀	....
Oregon	2j	1j	4j	2j
	....	....	2s	1s
	....	1♂	4♂	2♂
	....	2♀	3♀	1♀
Totals	2	7	32	10

* Although uniformly covered with melanophores, the eyelids may be slightly lighter than the skin of the head.
† j = juvenile; s = subadult; ♂ and ♀ = adults.

Tail.—Mottling of the tail, suggestive of the tail markings of *picta*, occurs in a certain percentage of adults, even as far north as Washington, an area geographically far removed from the zone occupied by *picta*. Of 13 animals from this state, 6 (3 ♂ and 3 ♀) have weakly mottled tails, but otherwise have uniformly distributed dorsal melanin. The one juvenile available with intact tail has *picta*-like markings and subadults may or may not have them. The trend in mottling of the tail follows that of the body.

In general, the light-colored longitudinal tail stripe, found in individuals from the zone of intergradation with *xanthoptica*, and occasionally present in the race *picta*, is absent in *oregonensis*.

Light-colored spotting of the tail, as observed in *oregonensis-platensis* intergrades, is approached by occasional individuals. An adult female, MVZ 42429, from Fogarty Creek, Lincoln County, Oregon, is so marked.

Sides.—All individuals have melanophores well below a line connecting the dorsal bases of the limbs. These grade into the uniform stippling of the ventral surfaces. They are irregular in arrangement, producing a mottled effect, with reduction in number usually occurring in the intercostal grooves (text fig. 3, p. 386).

Upper eyelids.—The eyelids are commonly dark colored, although occasional individuals exhibit lightening of the outer edges and some may have a

mottled style of coloration. The latter become more abundant as *picta* is approached (table 1, p. 397).

Limbs.—Animals from Oregon and Washington typically have half or less of the proximal segments of the limbs light colored. Farther south lightening increases but none has been observed with uniformly light-colored proximal elements. The cline in this character is shown in figure 11, page 479.

Ventral surfaces.—The majority of animals from Oregon and Washington are "medium" in development of ventral melanophores. In typical *oregonensis* these cells appear as minute pin points of black, forming a rather uniform stippling over nearly all ventral surfaces, but they are rare on the under surface of the tail and about the vent.

Pleuroperitoneum.—The lining of the body cavity is sprinkled with melanophores which are similar in number and in general distribution to those present ventrally.

LIPOPHORES

Juveniles may or may not have lipophores on the ventral surface of the body. Lipophores are nearly always present on the undersides of the limbs and tail. When present, they are usually most common ventrolaterally. With increase in size, they become more numerous and widely distributed.

Adults likewise commonly have a uniform network on the undersides of the limbs and tail, and occasional individuals have a continuous reticulum on the ventral surface of the body. More commonly, however, the network is rather irregular, forming a somewhat mottled style of coloration. Irregularity in distribution is often present in the gular area and on the chest; the abdomen is usually quite uniformly colored. Some individuals, especially young, have separate clusters of lipophores that form spots or blotches.

Reduction occurs as one proceeds northward. The few living animals available from northern Oregon and Washington suggest that weak development or even complete absence of these cells may be characteristic of the more northerly populations. Decline also occurs in the zone of intergradation with *platensis*.

The color of the lipoid pigment appears pale yellow, yellowish orange, or reddish orange. It seems to be considerably lighter than that found in *xanthoptica*. Similarly, the coloration of the dorsal surfaces of the proximal segments of the limbs, resulting from the presence of a close network of these cells, is less commonly orange. Sometimes the proximal segments are yellow, a condition so far not observed in *xanthoptica*, except in some juveniles.

Animals from Oregon and Washington suggest considerable variability in this character, the color, so far observed, ranging from pale yellow to reddish orange. Differences seem not to be correlated with sex or size, although further study may reveal moderately predictable color changes with growth.

A peculiarity of the lipoid coloration, occasionally encountered, should be pointed out. Some individuals have a lemon-yellow suffusion over the entire body instead of the more common yellowish orange or orange color. I found such an animal at Weott, Humboldt County, California. Mr. Slevin tells me he has also encountered them. The frequency of this aberrant type among indi-

viduals collected by me is 1 to 55. It also occurs in the race *picta* and—on the basis of my limited experience with this form—apparently more commonly.

GUANOPHORES

Skin.—Guanophores of two types are present, most notable in juveniles. One is pale blue, superficially located; the other is smaller, more diffuse, whitish or silvery, and more deeply situated. It is possible the differences may be due to position.

Young animals characteristically have extensive guanophore development. In some individuals, these cells are sprinkled over all surfaces except the proximal segments of the limbs. The ventral surfaces commonly lack them except for a few in the gular area and laterally on the abdomen. They are often reduced on the tail and distal segments of the limbs. They may largely be absent dorsolaterally on the body, in areas occupied by the dark blotches characteristic of the young.

Adults usually have reduced guanism, particularly on the dorsal surface of the body and tail. Guanophores are scarce ventrally although, as in the young, they may occasionally occur in the gular area and laterally on the abdomen. They are commonly concentrated on the sides of the head, neck, body, tail, and on the upper eyelids. A sprinkling on the sides of the body between the limbs is almost invariably present. A few may occur on the dorsal surface of the distal segments of the limbs.

Some individuals exhibit a heavy suffusion. Several from Hyampom, Trinity County, California, have the greatest development so far observed. One of them, an adult, has a hoary cast over all dorsal surfaces except for breaks on the proximal segments of the limbs. Ventrally, the cells are more scattered and they are absent on the underside of the tail.

On the basis of living animals available to me, it appears that guanism in *oregonensis* reaches its peak in northern California (and probably southwestern Oregon) in the relatively narrow zone between *picta* and *oregonensis-platensis* intergrades (text fig. 1, p. 378).

Iris.—Iridic guanism is highly variable. Occasional individuals lack guanophores, while rarely others are found that approximate *xanthoptica* in size and intensity of color of the eye patch. The mean condition is a patch that occupies about ¼ to ⅓ the area of the upper half of the iris. Rarely are the cells as closely set as in *xanthoptica*. The marking is frequently disrupted by the presence of darkly pigmented blood vessels that overlie it.

Guanophores may be present in the lower iris, forming a small marking that is never as well defined or as extensive as the upper one. In some individuals, only one or two guanophores may be present or they may be lacking.

The color of the iris markings is often yellow or gold but there is considerable range in hue. Other colors observed are silvery, copper, orange-yellow, and greenish yellow.

The entire range of variation in eye color, both as to degree of development and color of the iris markings, found in the species as a whole, is present in *oregonensis*.

DISTRIBUTION

Oregonensis occurs principally in the Transition Life-zone from southwestern British Columbia, on the mainland and Vancouver Island, south through Washington and Oregon, from the western slope of the Cascade Range to the coast, and south coastally in California, exclusive of the range of *picta*, to northern Sonoma County.

Altitudinally, the race is known from a few feet above sea level to 5,500 feet on South Fork Mountain, Trinity County, California. Without doubt it ranges higher, but this is not shown by records available to me.

Intergradation with *platensis* seems to occur in Jackson County, Oregon, probably in central Siskiyou County, and in eastern Trinity County, California, and with *xanthoptica* coastally south of the Gualala River in northern Sonoma County and, farther north, more interiorly, in the Ukiah Valley north of Willits. Intergrading areas are discussed in detail elsewhere (pp. 450–454 and 402–407).

In view of the gradual cline in dorsal blotching and changes in size and proportions, further complicated by variations with age, it is not possible to segregate satisfactorily localities of intergradation with *picta* from those of typical *oregonensis*. In the localities of collection that follow, only those considered as occupied by typical *picta* have been omitted.

Locality records.—BRITISH COLUMBIA: Gambier Island, Howe Sound, about 15 mi. NW Vancouver, and Cultus Lake, Vancouver region (Carl and Cowan, 1945:44); Vancouver;[3] Kitsiland, Vancouver;[3] Marpale;[3] 3 mi. by road SE town Lake Cowichan, Vancouver Is. (MVZ 1/1).

WASHINGTON: *Clallam Co.*—8 mi. S Cape Flattery (CNHM 2); Forks (CPS 1);[4] Tatoosh Island (CPS 1);[4] Port Angeles (CPS 2).[4] *Clark Co.*— Tum Tum Mountain, 1 mi. NE (CPS 2).[4] *Cowlitz Co.*—Ostrander, 2 mi. N (CPS 1).[4] *Grays Harbor Co.*—Hoquiam (CAS 5); Quinault (CAS 4); 3.6 mi. SSW Quinault, along U.S. 101 (MVZ 1/1); Vesta (CPS 1).[4] *Jefferson Co.*—Lake Quinault, 8 mi. NE (CPS 1);[4] Rainbow Camp (CPS 1);[4] along Hoh River road, 5.6 mi. ESE junction with U.S. 101 (MVZ 6/6). *King Co.*—4½ mi. E Bellevue, shore of Lake Sammamish, 70 ft. (MVZ 1); Bellevue (MVZ 3); ½ mi. S Paradise Lake (MVZ 4/4); Seattle and Univ. Wash. Campus, Seattle (AMNH 4, MVZ 2); Mercer Island (MVZ 2); Indian Point on Vashon Is. (CPS 1).[4] *Kitsap Co.*—Crystal Springs, Bainbridge Is. (CPS 8);[4] Gorst Cr. (CPS 1);[4] Blake Is., E side (CPS 5).[4] *Lewis Co.*—West Fork Tilton Trail, 4 mi. up from Highway (CPS 4).[4] *Mason Co.*—Skokomish River Valley (UMMZ 12); Skokomish River bank NW of U.S. 101 (CPS 3);[4] 3 mi. N Staircase Camp, Skokomish River, 5 mi. upstream from present Lake Cushman (MVZ 2); Lake Cushman (AMNH 10, MVZ 1, UMMZ 2), also 7 mi. N of intake (CPS 1);[4] Restwhile Camp (CPS 3);[4] Stretch Is. (CPS 2);[4] Ferry Landing, 1 mi. N, Harstine Is. (CPS 2);[4] Bear Gulch, Lake Cushman (CPS 2);[4] McMicken Is., NW side (CPS 10);[4] Squaxin Is., S end (CPS 2);[4] Hope Is., E side (CPS 1);[4] Hoodsport (AMNH 1). *Pacific Co.*—South Bend (CAS 1); Masell River Bridge (concrete), 2 mi. N (CPS 1);[4] Nemah, 7 mi. S (CPS 1).[4] *Pierce Co.*—McKenna (UMMZ 1); vicinity of Tacoma (MVZ 3); Tacoma (MVZ 1); Tacoma Stadium, below (CPS 1);[4] Anderson Is., N end (CPS 1);[4] Anderson Is. School House (CPS 2);[4] Ketron Is. (CPS 4);[4] Sylvan, Fox Is. (CPS 2);[4] Fox Is., W side (CPS 2);[4] Raft Is., central part (CPS 1);[4]

[3] Locality records for specimens in the collection of the University of British Columbia, sent by Dr. I. McT. Cowan.

[4] Records from the Museum of Natural History of the College of Puget Sound provided by Professor J. R. Slater. I have not seen these specimens hence cannot vouch for their identity.

Herron Is., SE cor. (CPS 1);[4] Elihi Hill, top, on Sumner-Buckley Highway (CPS 2).[4] *Snohomish Co.*—Monroe (Slevin, 1928); Maysville [Marysville?] (Dunn, 1926:194). *Thurston Co.*—Tenino (Slevin, 1928); Olympia, Capitol Grounds (CPS 1);[4] Snyders Prairie, 5 mi. NE (CPS 1);[4] Summit Lake, 6 mi. E (CPS 1).[4]

OREGON: *Benton Co.*—W Corvallis and Philomath (Gordon, 1939:57). *Clackamas Co.*—Cherryville (SNHM 1). *Coos Co.*—Marshfield (CAS 1); Coquille, 3.6 mi. SW (MVZ 3/3) and 9.4 mi. NNW (MVZ 1/1), along U.S. 101. *Curry Co.*—North side of Rogue River, 5 mi. above Silver Creek (MVZ 1). *Douglas Co.*—4.8 mi. by road NW Umpqua (MVZ 1/1). *Lane Co.*—13 mi. SE (MVZ 1/1) and 8.9 mi. SE Dexter, along State 58 (MVZ 2/2). *Lincoln Co.*—Fogarty Creek, ¼ mi. E of point where Oregon Coast highway crosses creek (MVZ 1/1). *Linn Co.*—3 mi. E Corvallis (MVZ 2); mouth of Moose Creek, 15 mi. E Cascadia and Peoria (Gordon, 1939:57). *Marion Co.*—Whitman Creek, Santiam River (MVZ 1); Salem (SNHM 1). *Multnomah Co.*—Portland and Washington Park, Portland (MVZ 8, CHAS 2, CNHM 3, SCB 4); Eastmoreland Golf Course, Portland (MVZ 4/4). *Tillamook Co.*—Blaine (MVZ 1); Wheeler (MVZ 2/2); Nehalem (Gordon, 1939:57). *Yamhill Co.*—McMinnville (Slevin, 1928).

CALIFORNIA: *Humboldt Co.*—Prairie Creek State Redwood Park, Franklin K. Lane Grove (SNHM 22); Benbow (SNHM 1); Kent Grove (LMK 2); Chas. B. Alexander Grove (SNHM 4); 1 mi. S Redcrest (SNHM 1), also 1.9 mi. N (MVZ 7/7); Dyerville (CAS 1); 10 mi. S Hartsook (CAS 3); Carlotta (MVZ 11), also 15.6 mi. SE (MVZ 5/5) and 6.2 mi. E (MVZ 5/5) on State 36; 2.6 mi. E Freshwater (MVZ 2/2); 2 mi. SE Eureka (MVZ 1); vicinity of Shively (CAS 4); vicinity N of Miranda (CAS 6), also vicinity S (CAS 2) and 12.9 mi. S on U.S. 101, near Garberville (MVZ 5/5); N Boundary Pioneer Grove, 16 mi. NW Garberville (MVZ 4); ¼ mi. N (MVZ 1) and 5 mi. N (MVZ 1) Garberville; 3 mi. E Kneeland P.O. (MVZ 13); 1 mi. S Scotia, Eel River (MVZ 5); vicinity of Meyers (CAS 3); vicinity S of Meyers (CAS 2); near Weott (CNHM 1); 2 mi. S Weott, at side U.S. 101 (MVZ 4/1), also 2.2 mi. N (MVZ 5/5); S of Weott (CAS 29); Van Duzen River, SE Strong's Station (MVZ 8); Maple Creek, 1 mi. N junction Mad River (MVZ 1); 2¾ mi. NW Pepperwood, near U.S. 101 (MVZ 1/1); Boise Creek Public Camp Ground, 800 ft., about 2 mi. W Willow Creek P.O. (MVZ 5/5). *Mendocino Co.*—Pudding Creek (UMMZ 1); Comptche (CAS 3), also near (CNHM 2) and 3 mi. E Comptche (Comptche-Ukiah Road) (SNHM 1); ½ mi. W Navarro (Boonville-Albion Rd.) (SNHM 3), also .6 mi. NW (MVZ 2/2); Boonville-Albion Road, 2 mi. W of road to Comptche (SNHM 6); De Voy Grove (SNHM 1); 16 mi. NW Cummings (CAS 3); Mendocino (CAS 15); 10 mi. SW Point Arena (CAS 5); 5 mi. SE of Usal (CAS 8); 8.9 mi. S Piercy, U.S. 101, near Lane's Redwood Flat (MVZ 2/2); 3 mi. N Gualala River near its mouth, W of State 1 (MVZ 5/5); 5 mi. S and 3.7 E Mendocino (MVZ 3/3). *Trinity Co.*—½ mi. NE Race Track, 5,500 ft., South Fork Mountain (MVZ 1), also 4,600 ft. on South Fork Mountain (MVZ 1); 2.7 mi. E Salyer on U.S. 299 (MVZ 1/1); Burnt Ranch, NE side U.S. 299 (MVZ 1/1); Big Creek, 4 mi. N and 2 mi. E Hayfork, 2,800 ft. (MVZ 5/5); 2 mi. W Hyampom, 1,200 ft. (MVZ 35/35).

NOMENCLATURE

With restriction of the name *eschscholtzii* to the unblotched *Ensatina* of southern California (p. 430), the remaining coastal ensatinas, aside from the races *picta* and *xanthoptica*,[5] are currently without a name. As indicated in preceding pages, this population is well differentiated and readily distinguishable from the others. I therefore revive for it the name *oregonensis* of Girard (1856).

Animals from the southern part of the range of this race in California are somewhat different from those in Oregon, Washington, and British Columbia. They are darker, less inclined toward irregular distribution of dorsal

[5] This race is newly described in the present paper.

melanophores, more often have a well-defined iris patch, have greater lipophore development of the ventral surfaces, and are slightly larger and have larger eyes than those to the north. When preserved, only the difference in color and distribution of the dorsal melanophores and the differences in body and eye size remain. In view of the difficulty in distinguishing alcoholics and the inadequate sampling of living animals from northern areas, I am not recognizing nomenclaturally the extremes in this clinal population.

INTERGRADES BETWEEN oregonensis AND xanthoptica

The principal changes that occur in pigmentation in the zone of intergradation between *oregonensis* and *xanthoptica* are as follows: (1) As *xanthoptica* is approached there is restriction of melanin as shown by lightening of the upper eyelids and proximal segments of the limbs and by loss of ventral and pleuroperitoneal melanophores. (2) The lipophores of the ventral surfaces become more extensive and the color of the intracellular pigment deepens; this deepening is further observed in the change in color of the proximal segments of the limbs from yellowish or yellowish orange to reddish orange. (3) Guanophores in the skin become less apparent while those of the iris become more abundant, culminating in the large yellow eye patch of *xanthoptica.*

In the following account variations in these characters, not readily apparent from study of text figures 11 and 13 (pp. 479 and 481), are analyzed.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Head and body.—There is no distinct north-south gradient, in the area of intergradation, in the intensity of dorsal melanism. Dark individuals come from areas in the Transition Life-zone whereas animals from the Upper Sonoran Zone tend to be lighter, irrespective of latitude. *Xanthoptica,* largely an Upper Sonoran race, is exceeded in depth of color by individuals from the intergrading area west of the Bay, a region principally Transitional in character although of similar latitude. Thus an adult female from Hecker Pass, Santa Clara County, and one from Waddell Creek, Santa Cruz County, respectively, southwest and west of the Bay, are almost black. These individuals are similar to heavily pigmented *oregonensis* from the southern part of its range.

Tail.—Animals from Mendocino County, particularly from the Ukiah Valley, are notable in the character of the tail markings. A series of 10 adults (4 ♂ and 6 ♀), from near Willits, are illustrative. Typically, the tail is bright reddish orange dorsally, giving way laterally to the less intense orange of the ventral surface. Dorsolaterally, superimposed on the light ground color, melanophores are distributed in an irregular manner, forming spots, blotches, stippling, and reticulations. Along the dorsal midline, occupying a strip about ¼ the width of the tail, is an area largely lacking them. The resulting reddish orange stripe has irregular margins and extends the length of the tail.

Although the tail stripe is best developed, so far as is now known, in the area mentioned, a tendency toward its formation can be seen in *xanthoptica.*

In this race, juveniles and occasional adults have a light line with irregular margins at the tip of the tail. As one enters the zone of intergradation north of the Bay, the stripe rapidly becomes better defined and longer, and the

TABLE 2

TAIL MARKINGS IN E. E. OREGONENSIS-XANTHOPTICA INTERGRADES

County	Absent	Tip mottled	Light line					Mottled like *picta*
			Distal ⅛	I.c.*	Distal ⅜	I.c.*	Total length of tail	
Santa Clara.........	3j	1j	2j	3j	1j	..	..	....
	5s	2s	1s	..	..	..	..	....
	3♂	3♂	..	..	..	..	..	....
	6♀	1♀	..	..	..	..	..	....
Santa Cruz..........	1j	1j	1j	10j	1j	1j	..	....
	6s	8s	..	..	2s	..	..	2s (one regen.)
	5♂	4♂	..	..	..	..	..	1♂
	10♀	..	..	..	..	..	..	2♀ (one regen.)
San Mateo..........	1j	..	..	..	..	..	6j	1j
	3s	1s	2s	..	1s	..	2s	....
	3♂	2♂	..	..	..	..	..	1♂
	2♀	3♀	1♀	..	2♀	..	..	....
San Francisco.......	..	..	..	1s	..	..	..	....
Marin..............	..	..	..	..	2j	1j	..	7j
	1s	..	..	1s	2s	..	1s	....
	2♂	6♂	..	..	..	1♂	..	....
	5♀	1♀	..	..	..	..	..	....
Sonoma............	..	..	..	..	1s	1s	..	1s
	1♀	..	..	..	1♀	..	1♀	1♀ (regen.)
Napa..............	..	..	..	..	..	..	6j	....
	..	..	..	..	..	..	2♂	....
Mendocino..........	..	..	..	..	..	..	5j	6j
	..	..	..	..	1s	1s	2s	5s
	3♂	..	..	..	..	..	4♂	10♂
	1♀	..	..	..	3♀	5♀	2♀	11♀ (two regen.)
Totals by age and sex............	5j	2j	3j	13j	4j	2j	17j	14j
	15s	11s	3s	2s	7s	2s	5s	8s
	16♂	15♂	..	..	..	1♂	6♂	12♂
	25♀	5♀	1♀	..	6♀	5♀	3♀	14♀
Grand totals......	61	33	7	15	17	10	31	48

* Intermediate category.

dorsolateral melanophores become irregular in distribution. A similar trend is seen in the area west of the Bay. In Santa Cruz County adults are generally without a light tail line, although some have mottlings at the tip of the tail; juveniles and subadults, however, may have the tail marked like some east-Bay animals. To the north, mottling and the tendency toward formation of a caudal stripe increases.

TABLE 3

VENTRAL MELANOPHORES IN E. E. OREGONENSIS-XANTHOPTICA INTERGRADES

County	General abundance							Detailed distribution										
	Absent	I.c.*	Slight	I.c.*	Medium	I.c.*	Great	Chin	Gular area	Post-gular area	Pec-toral region	Abdomen			Pelvis	Vent	Tail	All ventral surfaces
												Uni-form	Clus-tered	Irregu-lar				
Mendocino	....	....	....	....	3j	4j	1j	....	....	....	....	3j	5j	....	....	....	....	8j
	....	....	....	....	1s	3s	....	....	....	....	....	1s	3s	....	....	....	....	4s
	....	....	....	1♂	4♂	4♂	....	1♂	1♂	1♂	1♂	3♂	6♂	1♂	....	....	....	8♂
	....	....	....	....	5♀	8♀	....	1♀	1♀	1♀	1♀	7♀	6♀	1♀	....	....	....	12♀
Sonoma	....	....	....	....	2j	....	....	....	....	....	....	....	....	....	....	....	....	....
	....	1♂	....	1♀	2♀	....	....	....	....	....	....	....	....	....	....	....	....	....
Marin	....	....	1j	3j	2j	2j	....	9j	6j	7j	9j	3j	....	7j	5j	8j	4j	....
	....	....	....	3s	2s	....	....	5s	5s	5s	3s	1s	....	4s	2s	3s	....	....
	....	....	1♂	3♂	1♂	....	....	6♂	4♂	6♂	4♂	3♂	1♂	2♂	3♂	1♂	1♂	....
	....	1♀	3♀	6♀	....	....	....	10♀	6♀	8♀	5♀	2♀	1♀	6♀	3♀	5♀	2♀	....
San Mateo	....	....	1j	10j	1j	....	....	2j	2j	2j	1j	....	....	2j	....	....	....	....
	....	....	....	9s	2s	....	....	10s	9s	7s	7s	1s	....	9s	4s	6s	5s	....
	....	....	1♂	4♂	1♂	....	....	5♂	2♂	4♂	3♂	....	....	6♂	1♂	....	....	....
	1♀	....	....	6♀	....	....	1♀	9♀	9♀	8♀	8♀	....	1♀	8♀	1♀	1♀	2♀	....
Santa Cruz	....	6j	....	....	....	....	....	6j	1j	....	2j	....	4j	....	....	....	....	....
	....	2s	....	4s	....	....	....	6s	4s	4s	1s	....	4s	....	....	3s	2s	....
	4♂	5♂	1♂	2♂	....	....	....	8♂	4♂	7♂	3♂	....	4♂	4♂	1♂	4♂	1♂	....
	1♀	6♀	4♀	1♀	1♀	....	....	11♀	5♀	8♀	4♀	2♀	6♀	4♀	2♀	7♀	6♀	....
Santa Clara	1j	10j	1j	1j	....	....	....	10j	7j	8j	6j	....	8j	....	2j	5j	2j	....
	2s	6s	2s	1s	....	....	....	8s	4s	3s	1s	....	6s	....	2s	....	....	....
	4♂	3♂	1♂	....	....	....	....	2♂	2♂	....	....	....	2♂	1♂	....	1♂	1♂	....
	2♀	4♀	1♀	1♀	3♀	....	....	7♀	4♀	6♀	3♀	....	9♀	....	4♀	3♀	2♀	....
Totals by age and sex	1j	16j	3j	14j	8j	6j	1j	27j	16j	17j	18j	6j	17j	9j	7j	13j	6j	8j
	2s	8s	2s	17s	5s	3s	....	29s	22s	19s	12s	3s	13s	13s	8s	12s	7s	4s
	8♂	9♂	4♂	10♂	6♂	4♂	....	22♂	13♂	18♂	11♂	6♂	13♂	14♂	5♂	6♂	3♂	8♂
	4♀	11♀	8♀	15♀	11♀	8♀	1♀	38♀	25♀	31♀	21♀	11♀	23♀	19♀	10♀	16♀	12♀	12♀
Grand totals	15	44	17	56	30	21	2	116	76	85	62	26	66	55	30	47	28	32

In the race *picta,* mottling of the tail reaches its peak and some individuals have a dorsal light stripe but it is not as constant or conspicuous as in animals from the zone of intergradation between *oregonensis* and *xanthoptica.* Variation in tail markings is shown in table 2, p. 403.

Sides.—Melanophores extend below the limb line as in *oregonensis* and *xanthoptica* except for occasional individuals. Of 136 animals, of all ages, 11 were classed as "even with," 2 between "even with" and "above" and 1 "above" the limb line. The tendency toward lightening of melanic pigmentation in the costal grooves, observed in animals from Monterey County to the south, is found in varied degrees of development.

Upper eyelids.—The change from the dark uniformly pigmented or somewhat mottled eyelids of *oregonensis* to the light-colored eyelids of *xanthoptica* is gradual.

Limbs.—Reduction in melanophore distribution of the proximal segments of the limbs also is gradual.

Ventral surfaces.—*Xanthoptica* has much reduced ventral melanism whereas *oregonensis* typically has extensive, rather uniform stippling. Because of the marked differences between the two races, table 3 is included, showing changes that occur in the zone of intergradation.

Pleuroperitoneum.—Melanophore development of the lining of the body cavity closely follows that of the ventral surfaces.

LIPOPHORES

The distribution of ventral lipophores is similar to that found in *oregonensis,* but as *xanthoptica* is approached the frequency of individuals possessing a uniform network of these cells increases and a rather marked change occurs in their color—a deepening in intensity of the pigment and a change from yellowish to reddish orange. The reddish color is best developed in individuals from the Ukiah Valley southward. Animals from west-Bay areas more nearly resemble *oregonensis.* At Hecker Pass, Santa Clara County, the color of the venter closely approaches that of *xanthoptica.* This is to be expected because the locality lies at the juncture of the east- and west-Bay populations, south of San Francisco Bay.

GUANOPHORES

Skin.—There is a north-south trend toward reduction of guanism of the skin. To the north, adults, as well as juveniles, have extensive guanophore development. Animals from near Laytonville and Willits, Mendocino County, for example, usually have a sprinkling of guanophores over all dorsal surfaces, although these cells are fewer on the proximal segments of the limbs and on the tail. When present, guanism is weak on the ventral surfaces and is usually confined to the gular area, under sides of the limbs, and lateral surfaces of the body. Guanophores are most abundant on the sides between the limbs. In general, these animals closely resemble *oregonensis.* As one proceeds southward, there is suppression of guanophores of the skin. On the dorsal surfaces of the body, loss seems to progress from the tail anteriorly with reduction also occurring on the limbs and ventral surfaces. Thus animals from Marin

County, well to the south in the intergrading area, have guanophores largely confined to the sides, upper eyelids, and head. Juveniles, however, have more extensive guanophore development.

Few animals south of Golden Gate have been studied for this character. Those available closely parallel *xanthoptica*. An adult from La Honda, San Mateo County, has a few guanophores scattered along the sides, mostly between the limbs, and a few on the upper eyelids.

Iris.—The changes that occur in the development of the iris patch are shown graphically, figure 13, page 481. Animals from the intergrading zone, like *oregonensis*, exhibit a wide range of variability in size and color of the patch. As *xanthoptica* is approached, as shown by individuals from Hecker Pass, Santa Clara County, the frequency of well-developed eye patches increases.

DISTRIBUTION

The area of intergradation is considered as extending from the vicinity of Watsonville, Santa Cruz County, and Hecker Pass, Santa Clara County, immediately north of the mouth of the Salinas River, northward west of San Francisco Bay, across the Golden Gate, to northern Mendocino County in the vicinity of Laytonville. Along the extreme outer coast a slender tongue of typical *oregonensis* extends as far south as the mouth of the Gualala River, near the southern boundary of Mendocino County.

Intergrades give way to typical *xanthoptica* eastwardly north and south of the Bay. Animals from Hecker Pass closely approach *xanthoptica* in ventral lipophore development and guanism of the iris but have reduced light color on the proximal segment of the limbs and greater melanism of the eyelids. To the north, individuals that deviate noticeably from *xanthoptica*, appear in northern Napa County—as in the vicinity of Saint Helena—and in central Sonoma County—as at Guerneville. The uniform orange venter of *xanthoptica* gives way to a somewhat broken or mottled style of coloration and reduction in iridic guanism occurs, along with increase in melanism of eyelids and venter. To the west the appearance of deviates coincides closely with the juncture of the coastal Transition strip with the more generally Upper Sonoran area to the east.

Locality records.—CALIFORNIA: *Marin Co.*—Fort Baker, Phoenix Gulch, and Point Bonita (Slevin, 1928); S of Sausalito (UMMZ 1) and Sausalito (USNM 35); Muir Woods (MVZ 10/6, CAS 6); Redwood Canyon [Muir Woods] (AMNH 5); Mill Valley (Slevin, 1928); Mount Tamalpais (Slevin, 1928); ½ mi. N San Geronimo (SNHM 9); 3 mi. W and 6 mi. N Fairfax (MVZ 4/4); Lagunitas (Slevin, 1928); ¾ mi. NW Camp Taylor (MVZ 1/1); 1 mi. S Bootjack (MVZ 1/1); Tocaloma (Slevin, 1928); Inverness, 100 ft. (MVZ 10/7), 6 mi. W (MVZ 2), and 2 mi. WNW (MVZ 1); Pine Creek Gulch (UMMZ 2);[6] Big Carson Creek (CAS 1). *Mendocino Co.*—Near Yorkville (CNHM 15, MVZ 2, CM 3); Ornbaum Springs near Yorkville P. O. (SNHM 2); 2 mi. SE Hopland (MVZ 1); Ukiah (LMK 1); 4 mi. SE Ukiah (MVZ 1); Robinson Creek, 4 mi. SE Ukiah (MVZ 1); 7 mi. SW Willits (CAS 2); Willits (CNHM 1); 5.4 mi. S Baechtel Creek S of Willits, on U.S. 101 (MVZ 11/11); 3.8 mi. N Cloverdale (MVZ 2/2); 24.5 mi. S Lane's Redwood Flat, U.S. 101 (MVZ 7/7); Indian Creek near Philo (Boonville–Fort Bragg Road) (SNHM

[6] These localities are listed as within the intergrading zone on the basis of location and the study of preserved specimens. I have not seen living individuals from these areas.

1, MVZ 1/1); 2.5 mi. E Boonville (MVZ 1/1); Fairbanks (SNHM 1). *Napa Co.*—1 mi. E (MVZ 4/4) and 2.5 mi. E St. Helena on road to Sanitarium (fork of roads to Sanitarium and Pope Valley) (MVZ 7/7); Silverado Mine and Robert Louis Stevenson's home, Mt. St. Helena (MVZ 4/4); 6.7 mi. S Middletown (MVZ 2/2); Las Posadas Camp, 2 mi. SE Angwin (MVZ 1);[6] 6 mi. NNE Calistoga, about 1 mi. S county line (MVZ 2/2). *San Francisco Co.*—Sutro Forest (MVZ 1); San Francisco (AMNH 1). *San Mateo Co.*—La Honda (SNHM 10) and 1 mi. W (MVZ 2/2, SNHM 5); Old La Honda Road, just W Skyline Blvd. (SNHM 1); Pescadero Creek, about 2 mi. beyond La Honda (SNHM 4); small creek running down from coast range into Alpine Creek (SNHM 1); Los Trancos Woods (SNHM 3); 1.6 mi. SW junction State 9 and 5 on 9 (MVZ 1/1); Intersection of State 5 and road to Redwood City (MVZ 5/5); 7 mi. SW Redwood City (MVZ 1/1); Redwood City (Dunn, 1926); intersection of road to Woodside Store and road to Redwood City (MVZ 4/4); 3 mi. S Lake Pilarcitos, between Pilarcitos Creek and Stone Creek (SNHM 1); Skyline Blvd. (MVZ 1); Mills Lake (SNHM 1); Mindego Creek and San Gregorio road (MVZ 1/1). *Santa Clara Co.*—Hecker Pass, 1,000 ft., 9 mi. W and 2½ mi. N Gilroy (MVZ 24); 8 mi. W Gilroy (MVZ 1); 1 mi. E Madonna Road turn-off on Hecker Pass Road (MVZ 8/8); Los Gatos (CAS 2);[6] Steven's Creek (SNHM 1);[6] Stanford University campus (SNHM 2);[6] Palo Alto (SNHM 3);[6] Goat Ranch near Palo Alto.[6] *Santa Cruz Co.*—3 mi. E Watsonville on Hecker Pass Road (MVZ 1/1); Santa Cruz; 1½ mi. W Felton, 1000 ft. (MVZ 7); 2 mi W Felton (CAS 21); 1 mi. up Laguna Creek [from mouth?] (MVZ 1); Big Trees and Ben Lomond (SNHM 9); Ben Lomond (MVZ 1), and 1 mi. W (MVZ 1); 1 mi. W Covey's Cove (MVZ 2); 9.2 mi S Boulder Creek on State 9 (MVZ 7/7); Brookdale (Dunn, 1926); Los Gatos–Santa Cruz Highway (State 17), 1,450 ft., 1 mi. W county line (MVZ 4, SNHM 1); Los Gatos–Santa Cruz Road, 15 mi. from Los Gatos (MVZ 1); Waddell Creek, 2 mi. from ocean beach (MVZ 18); Waddell Creek, 100 ft. (MVZ 4, CNHM 3), within ½ mi. of Forks (MVZ 3), and Rancho del Oso (SNHM 6); Steven's Camp off Waddell Creek (SNHM 3); 4 mi. E Big Basin (MVZ 1/2); Big Basin (SNHM 4); 3 mi. SSW Alma, 2,000 ft. (MVZ 3). *Sonoma Co.*—3.8 mi. W Sebastopol (MVZ 1/1); Guernewood, about ½ mi. W Guerneville (MVZ 4/4); 2.8 SE Fort Ross (MVZ 1/1).

Ensatina eschscholtzii xanthoptica subsp. nov.

Plethodon eschscholtzii, Grinnell and Camp, 1917:17, part.
Ensatina eschscholtzii, Dunn, 1923*a*:39, part.
Ensatina croceator, Slevin, 1930:78, part.

Type.—Adult male, no. 41726, Museum of Vertebrate Zoölogy, collected by the author, November 25, 1945, 4.5 miles east Schellville, Napa County, California.

Measurements (in mm., taken in life) and tooth and costal groove counts of type.—Snout-vent, 67.1; tail, 70.1 (greatest width 5.5, greatest depth 6.1); head and neck, 23.2; snout to gular fold, 19.0; axilla to groin, 30.9; fore limb, 22.7; hind limb, 23.1; forefoot, 5.86; hind foot, 8.51; interorbital distance, 3.9; eye opening, 4.37; anterior eye corner to nostril, 4.32; anterior eye corner to eye corner, 5.8; vomerine teeth, 23; parasphenoid teeth, 51;[7] costal grooves, 12.

Coloration of type.—Above Seal Brown to Blackish Brown (2), extending on sides to or a little below a line connecting upper surfaces of limbs; lower limits of dark dorsal coloration, particularly on sides between limbs, irregular and somewhat mottled; ground color of eyelids Salmon Orange; below Apricot Orange except on abdomen and lower thoracic region where Ferruginous; ventral orange color brighter where it approaches dark dorsal coloration—

[7] Tooth counts made on right side only.

Flame Scarlet on sides of head and Grenadine Red on sides of body and tail; a few melanophores on chin, a 5 mm. melanic patch in right postgular area, and patches on soles of hind feet, ventral surfaces otherwise without melanophores; proximal segments of limbs Grenadine Red above; distal segments similar in ground color to proximal segments but with mottling of melanophores on fore limbs and rather extensive network on hind limbs, obscuring lipophore ground color; orange color lightens on toes to Salmon Orange; guanophores present but indistinct, situated on dorsal and lateral surfaces of body and head, including eyelids; none observed on tail, limbs, or ventral surfaces; guanophore patch present beneath lipophore network at base of upper side of limbs as in *oregonensis;* iris with most of upper half Picric Yellow; no guanophores in lower part.

In view of the uniformity in pigmentation of adults, the description of the type is adequate for the race as a whole.

Color changes with growth.—Juveniles uniformly orange brown above lightening to orange or reddish orange toward tip of tail, probably partly due to thinning of melanophores distally; upper eyelids usually lighter than head, often with yellowish cast; ventral surfaces buff to whitish but close examination reveals presence of lipophores in varying numbers; some juveniles have continuous lipophore network over all ventral surfaces, others may have central longitudinal region on body and narrow margin about vent without them; areas of loosely arranged lipophores may appear whitish on casual examination; undersides of proximal segments of limbs usually yellowish; ventral surfaces essentially without melanophores but occasionally some may be present, usually on tip of chin, in gular area, and a few in scattered clusters on body; proximal segments of limbs orange or yellowish orange above; distal segments colored like upper surface of body; feet orange above, buffy below; guanophores pale blue to silvery, numerous on eyelids, head, and body, thinning on tail and largely absent from proximal segments of limbs; present on distal segments of limbs and sides of body and neck, seldom present ventrally; iris with well-developed yellow patch occupying most of upper part and with or without a small patch in lower part.

With growth, melanin becomes more pronounced, darkening dorsum of body and distal segments of limbs; buff or whitish coloration of ventral surfaces changes to uniform orange as lipophores become more abundant and more deeply pigmented; coloration shifts from yellowish orange to orange or even reddish orange, most noticeably so on proximal segments of limbs; guanophores become obscure.

Diagnosis.—Distinguished from *platensis, croceator,* and *klauberi* by absence of light-colored dorsal spots or blotches, more extensive iridic guanophore development, uniformly orange venter and scarcity of ventral melanophores; distinguished from *oregonensis* and *picta* by lack of extensive and uniformly distributed ventral and pleuroperitoneal melanophores and from *picta* further by absence of dorsal dark blotching; distinguished from *eschscholtzii* by more extensive melanophore development of sides, yellow eye patch, and orange venter.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Head and body.—The melanophores of the head and body are arranged in the form of a close network that imparts a uniformly dark coloration to the dorsal surfaces. There is no irregularity in distribution as sometimes appears in the races *eschscholtzii* and *oregonensis,* where a salt and pepper or minutely mottled style of coloration may occur. Even juveniles possess a uniform reticulum, none having been seen with the stipple arrangement found in some young *eschscholtzii.* Nevertheless, young animals tend to be lighter than adults.

TABLE 4

TAIL MARKINGS IN E. E. XANTHOPTICA

County	Absent	Tip mottled	Tip with light line
Sonoma..............	....	....	1♂
Napa................	....	1s	1j
	....	....	1s
	1♂	1♂	1♂
	....	2♀	....
Alameda and Contra Costa..............	....	....	8j
	2s	2s	4s
	2♂	4♂	2♂
	7♀	4♀	3♀
Santa Clara..........	1♂	2♀	1j
Totals by age and sex	....	....	10j
	2s	3s	5s
	4♂	5♂	4♂
	7♀.	8♀	3♀
Grand totals........	13	16	22

In comparing series of preserved specimens, *xanthoptica* averages darker, at all sizes, than *eschscholtzii* but is surpassed in intensity of melanic pigmentation by some *oregonensis* and *oregonensis-xanthoptica* intergrades.

Tail.—Adults typically have uniformly colored tails that resemble the body in intensity of melanic coloration. Some individuals, however, especially juveniles and subadults, possess reduced melanism toward the tip. The distal third, quarter, or less may be mottled or a narrow longitudinal stripe of light color may extend varying distances toward the base. The mottled style of marking seems to be more common in adults than juveniles. The mottled coloration is similar to that found in *eschscholtzii* but is seldom as extensive, since at least the basal two-thirds of the tail is uniformly colored in all animals examined (table 4).

Sides.—The melanophores of most individuals extend below a line connecting the bases of the dorsal surfaces of the limbs. The margin of this melanic coloration is diffuse less often than in *eschscholtzii* where, in keeping with the general tendency toward somewhat irregular distribution of melanophores,

the edge of the dark pigmentation is frequently somewhat mottled. The extent of melanism stands in contrast with that of *eschscholtzii* which usually has the margin of the melanistic pigmentation even with or above the limb line.

There appear to be no sex or age differences in this character but there seems to be some geographic variation, since only one of 28 animals from Alameda and Contra Costa counties was classed as having dorsal pigmentation even with the limb line whereas all individuals (4) from Santa Clara County, farther south, were so classified (table 5).

TABLE 5

MELANOPHORES ON SIDES OF BODY IN E. E. XANTHOPTICA

County	Even with line connecting upper bases of limbs	Relationship to line connecting upper bases of limbs uncertain	Below line connecting upper bases of limbs
Sonoma	1♂	....	....
Napa	1j	....	....
	....	1s	1s
	1♂	1♂	1♂
	....	1♀	1♀
Alameda and Contra Costa	....	2j	2j
	....	1s	4s
	1♂	2♂	4♂
	....	4♀	8♀
Santa Clara	1j	....	....
	1s	....	....
	1♂	....	....
	1♀	....	....
Totals by age and sex	2j	2j	2j
	1s	2s	5s
	4♂	3♂	5♂
	1♀	5♀	9♀
Grand totals	8	12	21

All individuals were classed as having melanophores extending to a line connecting the upper bases of the limbs or extending below such a line. None was found with the melanic pigmentation stopping short of the limb line.

Upper eyelids.—*Xanthoptica* closely resembles *eschscholtzii* in the melanophore development of the eyelids as comparison of tables 6 and 11 (pp. 411, 424) will make clear. However, an essential difference is present in the ground color. In *xanthoptica* it is typically yellowish orange (often Salmon Orange), whereas in *eschscholtzii* it is usually buff or whitish with a pinkish tinge. Occasional individuals of *eschscholtzii* have orange lids but none has been observed with the yellowish cast of *xanthoptica*.

Limbs.—Of 39 individuals, 24 (62 per cent) possess uniformly light-colored proximal segments of the fore limbs and 14 (36 per cent) have similarly colored hind limbs. The remainder have some encroachment of melanophores on to the proximal segments, extending in several individuals to the base of the limbs. *Xanthoptica* closely resembles *eschscholtzii* in degree of melanism of the proximal segments but appears more often to have pronounced blotching of these elements (table 7, p. 412).

Variation with sex, age, or geographic position is not apparent.

Ventral surfaces.—Of 53 individuals, about 5.6 per cent have no ventral melanophores whatever in contrast to 12.5 per cent for *eschscholtzii*. Forty-five (85 per cent) are below pattern type "slight" in melanic development. The two races are comparable in the distribution of ventral melanophores but *xanthoptica* more often has them in the gular, pectoral, and pelvic regions and tends more toward formation of ventral blotches or spots consisting of clusters of these cells (table 8). In general, the two subspecies are quite similar in ventral melanism.

TABLE 6

MELANOPHORES OF UPPER EYELIDS IN E. E. XANTHOPTICA

County	Between absent and slight	Slight	I.c.*	Medium	Between medium and great
Sonoma	..	..	1♂	..	..
Napa	..	..	1j	..	..
	..	1s	1s	..	..
	..	..	1♂	..	2♂
	1♀	..	..	1♀	..
Alameda and Contra Costa	1j	..	4j	2j	..
	2s	1s	4s	2s	..
	..	1♂	4♂	2♂	1♂
	..	2♀	6♀	3♀	2♀
Santa Clara	..	..	..	..	1j
	..	..	1s	..	..
	..	..	..	1♂	..
	..	..	..	1♀	..
Totals by age and sex	1j	..	5j	2j	1j
	2s	2s	6s	2s	..
	..	1♂	6♂	3♂	3♂
	1♀	2♀	6♀	5♀	2♀
Grand totals	4	5	23	12	6

No individual entirely lacked melanophores nor was any individual classed as having great or mottled melanic pigmentation.

* Intermediate category.

Pleuroperitoneum.—*Xanthoptica* resembles *eschscholtzii* in generally lacking pleuroperitoneal melanophores. Twenty-three individuals from Alameda and Contra Costa counties and three from Napa County were examined.

LIPOPHORES

One of the conspicuous characteristics of the race *xanthoptica* is its extensive lipophore development. In adults, this includes all surfaces of the skin, the orange coloration being particularly noticeable on the ventral surfaces where it is not obscured by melanophores. As pointed out earlier (p. 408), weak development of lipophores ordinarily is found only in young animals but this is by no means invariably the condition in the young for they may have a rather uniform network. In over 150 individuals seen alive, I have encountered only one that generally lacked these cells on the ventral surface of the

TABLE 7

EXTENT OF LIGHT COLOR ON PROXIMAL SEGMENTS OF LIMBS IN E. E. XANTHOPTICA

County	Fore limb									Hind limb									Mottled or spotted
	Light	I.c.*	3/4 light	I.c.*	1/2 light	I.c.*	1/4 light	I.c.*	Dark	Light	I.c.*	3/4 light	I.c.*	1/2 light	I.c.*	1/4 light	I.c.*	Dark	
Sonoma....	1♂	....	....	....	....	....	....	....	....	1♂	....	....	....	....	....	....	....	....	1♂
Napa	....	....	1j	....	....	....	....	....	....	....	....	....	....	1j	....	....	....	....	1j
	1s	....	....	1s	....	....	....	....	....	1s	....	....	....	1s	....	....	....	....	2s
	2♂	....	....	....	....	1♂	....	....	....	....	1♂	....	....	2♂	....	....	....	....	2♂
	2♀	....	....	....	....	....	....	....	....	1♀	....	....	1♀	....	....	....	....	....	....
Alameda and Contra Costa	....	....	....	....	....	....	....	....	....	....	....	1j	....	1j	....	....	....	....	....
	4js	....	....	....	....	....	....	....	....	2js	....	....	....	....	....	....	....	....	....
	3♂	....	....	....	3♂	....	1♂	....	....	3♂	....	....	....	3♂	....	1♂	....	....	6♂
	8♀	....	2♀	....	2♀	....	2♀	....	1♀	4♀	....	2♀	....	5♀	....	2♀	....	2♀	9♀
Santa Clara	1j	....	....	....	....	....	....	....	....	1j	....	....	....	....	....	....	....	....	....
	1s	....	....	....	....	....	....	....	....	1s	....	....	....	....	....	....	....	....	....
	1♂	....	....	....	....	....	....	....	....	....	....	....	....	....	1♂	....	....	....	1♂
	....	....	....	1♀	....	....	....	....	....	....	....	....	....	1♀	....	....	....	....	1♀
Totals by age and sex	....	....	1j	....	....	....	....	....	....	....	....	1j	....	2j	....	....	....	....	1j
	7js	....	....	1s	....	....	....	....	....	5js	....	....	....	1s	....	....	....	....	2s
	7♂	....	....	....	3♂	1♂	1♂	....	....	4♂	1♂	....	....	5♂	1♂	1♂	....	....	10♂
	10♀	....	2♀	1♀	2♀	....	2♀	....	1♀	5♀	....	2♀	1♀	6♀	....	2♀	....	2♀	10♀
Grand total	24	....	3	2	5	1	3	....	1	14	1	3	1	14	1	3	....	2	23

TABLE 8

Ventral Melanophores in E. e. xanthoptica

County	General abundance†				Detailed distribution								
	Absent	I.c.*	Slight	Between slight and medium	Chin	Gular area	Postgular area	Pectoral region	Abdomen: Clustered	Abdomen: Irregular	Pelvis	Vent	Tail
Sonoma............	....	1♂	....	....	1♂	....	....	....	....	....	....	....	...
Napa..............	....	1j	....	....	1j	1j	....	....	....	....	1j	1j	...
	....	2s	....	....	2s	....	....	....	....	....	....	1s	...
	....	3♂	....	....	3♂	1♂	1♂	1♂	1♂	....	....	....	...
	....	1♀	....	1♀	3♀	2♀	2♀	1♀	1♀	1♀	1♀	1♀	...
Alameda and Contra Costa	....	7j	....	....	7j	7j	2j	1j	5j	....	1j	2j	...
	1s	5s	....	1s	5s	4s	....	....	1s	....	1s	....	...
	....	9♂	....	....	5♂	7♂	1♂	....	4♂	....	2♂	1♂	1♂ (regen.)
	1♀	12♀	4♀	1♀	12♀	12♀	6♀	4♀	9♀	....	2♀	3♀	1♀ (regen.)
Santa Clara	....	1j	....	....	1j	1j	1j	....	1j	....	....	1j	...
	1s	....	....	....	....	....	....	....	....	....	....	....	...
	....	1♂	....	....	....	1♂	....	....	1♂	....	....	....	...
	....	....	....	1♀	1♀	1♀	1♀	1♀	1♀	....	1♀	1♀	...
Totals by age and sex	....	9j	....	....	9j	9j	3j	1j	6j	....	2j	4j	...
	2s	7s	....	1s	7s	4s	....	....	1s	....	1s	1s	...
	....	14♂	....	....	9♂	9♂	2♂	1♂	6♂	....	2♂	1♂	1♂
	1♀	13♀	4♀	3♀	16♀	15♀	9♀	6♀	11♀	1♀	4♀	5♀	1♀
Grand total	3	43	4	4	41	37	14	8	24	1	9	11	2

* Intermediate category.
† No individual was classed as medium or great in general abundance of ventral melanophores nor did any individual have uniform distribution of abdominal melanophores.

body. This was a subadult, resembling closely, in ventral lipophore development, some members of the race *eschscholtzii*. In other respects it was typically *xanthoptica*. It is notable that the animal came from the easternmost locality for the race, from Mount Diablo, bordering on the Great Valley, a somewhat drier region than that occupied by animals nearer the Bay.

GUANOPHORES

Skin.—Juveniles are minutely speckled with pale blue and whitish guanophores on the head (including the eyelids), neck, and body. These cells are often reduced posteriorly on the lower back, pelvic region, tail, and distal segments of the limbs. They are usually present on the sides of the body and rarely—in small numbers—ventrally, particularly in the gular region. They have not been observed superficially on the proximal segments of the limbs.

Guanophores are still apparent in half-grown individuals, although they are less conspicuous and abundant than in the young. They are undetectable in some adults but in others they can be made out faintly, magnification often being required. In general in *xanthoptica* they are more abundant, widespread, and can be detected in larger individuals than in *eschscholtzii*.

Iris.—*Xanthoptica* characteristically possesses extensive guanophore development of the upper portion of the iris. The cells are closely set, usually forming a uniform patch of yellow which occupies most of the upper half. The patch typically extends from the upper edge of the horizontally oval pupil to near the base of the upper conjunctival sac. Occasional breaks in the network occur through which the dark brown melanic background color may be seen, and the presence of blood vessels, sometimes with associated melanophores, may further disrupt the eye patch.

Guanophores may or may not be present in the lower iris. When present, their number is variable, ranging from one to many cells, but never forming a patch as conspicuous as that of the upper iris. A diffuse blotch occupying ¼ the area of the lower half is the maximum size in animals I have studied.

The size of the patches in the two eyes of an individual are usually similar, although not invariably. Marked asymmetry was noted in an adult female from Alum Rock Park, 7 miles east of San Jose, Santa Clara County, California. This individual had one eye completely dark brown and the other with a fully developed eye patch. A male and juvenile found with her had well-developed iridic patches. Animals with less pronounced asymmetry are more common.

Loss of the eye patch in this individual may reflect the influence of factors affecting the race *eschscholtzii* which characteristically lacks iridic guanophores. The nearest locality of record for intergrades with this race occurs about 37 miles to the south. These animals resemble *xanthoptica* in lipophore and melanophore development but have much reduced or no guanophores in the iris (page 418).

All individuals examined (150) including juveniles, subadults, and adults from all counties in which the race is known, were classed as having "heavy" development of iridic guanophores (text fig. 13, p. 481).

DISTRIBUTION

The race *xanthoptica* is found mostly in the Upper Sonoran Life-zone. The Transition Zone is of limited occurrence within its range, appearing on the high points and north- and northeast-facing slopes of the Berkeley Hills. To what extent the race inhabits this zone in the Sierra Nevada where it has recently been found is unknown (see page 449).

The present known range is as follows: The Coast Range of California between the Central Valley and San Francisco Bay, as far north as east-central Sonoma County near Santa Rosa and south to Alum Rock Park near San Jose in northern Santa Clara County. The western limit coincides closely with the boundary between the Transition and Upper Sonoran life-zones north and south of the Bay. To the east it occurs in the Sierra Nevada opposite San Francisco Bay on Jawbone Ridge, Tuolumne County, and probably at Bear Valley, Mariposa County, California.

In altitude, *xanthoptica* is known to range from a few feet above sea level to approximately 3,100 feet on Jawbone Ridge, Tuolumne County, California.

Locality records—CALIFORNIA: *Alameda Co.*—W side Arroyo Mocho, 15 mi. SE Livermore (MVZ 2/2); Calaveras Reservoir (MVZ 1); Niles Canyon at Joyland Park (MVZ 2/2); Redwood Peak (CAS 2); 1 mi. S N Park Entrance, Redwood Regional Park, Oakland (MVZ 2/2); Temescal Canyon, Oakland (MVZ 1); Oakland (CNHM 2); Berkeley (MVZ 2, LMK 1, CNHM 2, AMNH 6, USNM 1); Indian burying ground, N Berkeley (MVZ 1); Berkeley, Glen Avenue (MVZ 4); S rim Strawberry Canyon, Berkeley (MVZ 4); Strawberry Canyon (MVZ 6); Arlington District, Berkeley (MVZ 5); E of Botanical Gardens, Strawberry Canyon, Berkeley (MVZ 1/1); Claremont Canyon near Berkeley (MVZ 1). *Contra Costa Co.*—Canyon (MVZ 2/2); San Leandro Creek, 500 ft., 1½ mi. SW Moraga (MVZ 2); Las Trampas Creek, 500 ft., 1 mi. N St. Mary's College (MVZ 9); near San Pablo Creek, Orinda (MVZ 5/5); Lot 43, Lafayette Terrace, Lafayette (MVZ 1); Wildcat Canyon, 3 mi. NE Berkeley (MVZ 10); Wildcat Canyon (CNHM 1); E bank Wildcat Creek 100 yds. W Indian Picnic Grounds, Tilden Regional Park (MVZ 1/1); Berkeley (MVZ 1); 1 mi. NW Alamo, 275 ft. (MVZ 2); Mount Diablo, South Diablo Rd., "Garden of the Jungle Gods" (MVZ 1/1). *Marin Co.*—6 mi. SW Petaluma on Pt. Reyes Road (MVZ 1/1). *Napa Co.*—Huichica Creek, 200 ft. (MVZ 2, SNHM 2); 4.5 mi. E Schellville (MVZ 2/2); Napa (LMK 1). *Santa Clara Co.*—2 mi. N Calaveras Road on Weller Road, Milpitas (MVZ 1/1); Alum Rock Canyon (SNHM 2); Alum Rock Park (MVZ 3/3). *Sonoma Co.*—Petaluma (Slevin, 1928:62); 13.6 mi. SE Santa Rosa on E side of State 12 (MVZ 1/1); Agua Caliente (Storer, 1925:110); 3 mi. E and 1 mi. N Santa Rosa (MVZ 2/2). *Tuolumne Co.*—Jawbone Ridge, 4.5 mi. (8.9 mi. by road) SSW Jawbone Station, 3,100 ft. (MVZ 10/10, including one *xanthoptica-platensis* hybrid).

INTERGRADES BETWEEN **xanthoptica** AND **eschscholtzii**

The zone of intergradation is of considerable size, extending 150 miles from immediately south of San Francisco Bay to near Point Concepcion. Toward the south the conspicuous lemon-yellow eye patch disappears abruptly and completely; the orange coloration of the ventral surfaces becomes limited to the undersides of the limbs and tail or is wholly lost; the melanophores become restricted in distribution; and the guanophores of the skin of adults largely disappear.

In the absence of significant changes correlated with age and sex in characters studied, attention is directed to geographic trends. Those not shown in the chart (text fig. 11, p. 479) are discussed here, along with special features

ANALYSIS OF COLORATION

MELANOPHORES

Head and body.—In comparing large numbers of typical *xanthoptica* and *eschscholtzii* with animals from the intervening area it is apparent that the latter are, on the average, intermediate between the two races in intensity of melanic coloration. Examination of the melanophores under magnification confirms the impression derived from macroscopic study. Some juveniles from the intergrading zone have the melanophores spaced to form what is closer to dorsal stippling than a reticulum, a condition often found in young *eschscholtzii* but which has not yet been observed in *xanthoptica.*

Tail.—Of 33 individuals, most have uniformly colored tails but juveniles may exhibit slight lightening of the tip, although somewhat less markedly than in *xanthoptica.* One subadult from Big Sur and an adult female from Monterey have tails that are slightly mottled distally.

Other characters.—Trends in the distribution of melanophores on the sides of the body, eyelids, limbs, and ventral surfaces are shown in text figure 11, page 479. The general tendency is toward increasing restriction of areas marked by these cells as one proceeds southward.

A peculiarity of animals from Big Sur, Monterey County, should be pointed out. Of 11 adults from this locality, all but 2 possess marked lightening along the costal grooves. Although such a tendency is seen in both *xanthoptica* and *eschscholtzii,* it is surpassed by this series. Of 6 animals from Monterey, farther north, only one compares with those from Big Sur. Under magnification, the lightening is observed to be due primarily to differential distribution of the pigment of the melanophores; those in the darker areas have their radiating processes filled while those in the costal grooves appear as black dots. Since the Big Sur series consists of three accessions, collected several years apart, it appears unlikely that lightening in the costal grooves can be due to differing methods of preservation. This characteristic parallels a condition found in *xanthoptica-oregonensis* intergrades immediately north of Salinas Valley, along the coast. These animals live in the redwood belt, an environment similar to that occupied by the Big Sur population.

An adult individual from near Atascadero, San Luis Obispo County, has a round spot, 1.8 mm. in diameter, on the head behind the eyes. The mark was probably orange in life. Another animal, a subadult from near Monterey, Monterey County, has a spot 1 mm. in diameter on the lower back. The percentage of these individuals in the total studied is 1.6. In them is observed a suggestion of the feature of pigmentation characteristic of the Sierran race *platensis.*

The number of ventral melanophores and their distribution in the intergrades is more variable than in the adjoining races. Probably because most of the animals come from nearer the range of *xanthoptica* than that of *eschscholtzii,* they tend to resemble the former more closely. Although a greater percentage of individuals lack ventral melanophores than in the race *xanthoptica,* there is nevertheless a tendency toward more extensive melanism.

The greater range of variability in melanin may be related to merging of the west-Bay population, considered intergradient between *oregonensis* and *xanthoptica,* with *eschscholtzii-xanthoptica* intergrades south of the Bay. The condition is probably influenced further by the presence of a Transition area of considerable extent, south of Salinas Valley, from which come considerable numbers of the animals used in the analysis. In general, individuals from Transition areas incline toward greater melanism.

Like *xanthoptica* and *eschscholtzii,* intergrades largely lack melanophores in the lining of the body cavity except about the large blood vessels at the attachment of the dorsal mesentery.

LIPOPHORES

There is reduction in ventral lipophore development as one proceeds southward. This results from loss of lipophores principally on the underside of the head and body, those of the limbs and tail remaining. All individuals (4) from near San Juan Bautista, San Benito County, have uniformly colored orange ventral surfaces. Of four from the vicinity of Monterey, two are so colored, although somewhat less intensely than in *xanthoptica;* the others have a whitish gular area and abdomen. All seven animals from Big Sur, farther south, show reduction of lipophores on the body and throat. An individual from near Gonzales, east of the Salinas Valley, has lipophores on the chest and upper abdomen but the gular area and lower abdomen are whitish. Three animals from Atascadero, San Luis Obispo County, have irregular lipophore clusters on the body and throat. Four individuals from Lompoc, Santa Barbara County, considered as *eschscholtzii,* have somewhat more ventral lipophore development than typical members of this race. Although lipophores are absent centrally on the ventral surface of the head and body, there is greater extension of the color of the sides on to the venter than is ordinarily found farther south.

From this scattered group of animals an even cline of some extent is suggested. More collecting will be required to show accurately the nature of this character gradient.

The yellowish cast in the lipophore coloration of *xanthoptica* is carried at least as far south as Atascadero, San Luis Obispo County. Two juveniles from this locality have a yellowish tinge to the eyelids and proximal segments of the limbs.

Although with preserved specimens, the coloration of the ventral surfaces is not a reliable method of differentiating individuals, when large series are compared, differences are readily seen. Thus preserved, *xanthoptica* and intergrades with *eschscholtzii* range, in adults, from Warm Buff to Antimony Yellow whereas *eschscholtzii* ranges from Pale Ochraceous-Salmon to Light Ochraceous-Buff. Juveniles and subadults, however, are commonly as light colored as *eschscholtzii.*

GUANOPHORES

Skin.—So few specimens have been checked for degree of development of the guanophores of the skin, that a reliable analysis cannot be presented at this

time. The few animals studied suggest a rather rapid loss or obscuring of these cells south of Salinas Valley. Perhaps the trend will be found to follow that of the eye patch, discussed beyond.

Iris.—The yellow eye patch, a conspicuous characteristic of *xanthoptica*, is almost completely lost in the area between Alum Rock Park in northern Santa Clara County and the vicinity of San Juan Bautista in northern San Benito County, a distance, in an air line, of about 44 miles. Of four animals from the last locality, one has six faint orange guanophores in one eye. The other eye and the eyes of the remaining individuals are uniformly dark colored. No specimens are available from the intervening area. Similarly, an abrupt change occurs coastally; individuals from Hecker Pass, Santa Clara County, usually have well-developed eye patches and animals from Monterey, Monterey County, about 25 miles to the south, on the opposite side of the Salinas Valley, are without them. As with the San Juan Bautista animals, a remnant of the eye patch may be present. One individual of four available has a single iridic guanophore in the upper iris of one eye.

In marked contrast to other characters analyzed, the trend in the eye patch is in the form of a step cline, the change from maximum development to complete absence, occurring within a few miles.

In summary, essential facts regarding character gradients in the extensive zone of intergradation are: (1) There is a gradual cline from north to south in the reduction of melanophores—the eyelids become lighter, dark pigment becomes reduced on the sides of the body, and melanophores largely disappear from the ventral surfaces and lining of the body cavity. (2) There is a similar cline in the reduction of lipophores on the ventral surface of the head and body. (3) There is a step cline in the reduction of iridic guanophores and possibly a similar decline in number of skin guanophores, the former and probably also the latter occurring in the vicinity of the lower Salinas Valley.

Because of the gradual changes involved in such characters as melanism and ventral lipophore development, the arbitrary nature of lines delimiting the zone of intergradation is apparent. It might be desirable from the standpoint of convenience in nomenclature to consider the range of *eschscholtzii* as extending to the Salinas Valley. In the interests of consistency, however, this would require modification of viewpoint with respect to other similar areas of intergradation.

DISTRIBUTION

The area of intergradation extends from the Monterey Peninsula, Monterey County, and the vicinity of San Juan Bautista, San Benito County, south in the coast ranges to Atascadero, central San Luis Obispo County, California.

Most individuals have come from the Transition Life-zone along the extreme outer coast. Few are available from the much more extensive Upper Sonoran areas although the salamanders are probably widely distributed in this zone. They probably do not occur in the Lower Sonoran Zone on the floor of Salinas Valley. Altitudinally, they are known to range from near sea level, at the sand dunes at Carmel, Monterey County, to 3,000 feet at Butts Ranch, San Benito County.

Locality records.—CALIFORNIA: *Monterey Co.*—Big Sur State Park (MVZ 5/5); 1 mi. NW Big Sur (MVZ 24/2); Palo Colorado Creek (MVZ 2); Carmel (MVZ 2, CAS 43, AMNH 4, CNHM 5, LMK 4, UMMZ 4); Sand dunes, Carmel (MVZ 1); Carmel Valley, 12 mi. E Carmel (MVZ 1); San Clemente Creek, 1,500 ft., 11 mi. SE Carmel Mission (MVZ 2); 4 mi. E Carmel Mission (MVZ 1); Robles del Rio (CM 9); Mud Creek, 800 ft., 3½ mi. SW San Juan (MVZ 1); Muddy Creek, 750 ft., Chualar Canyon (MVZ 3); 3 mi. E, 2 mi. S Jamesburg (MVZ 2/2); Presidio, Monterey (MVZ 1); Monterey (CAS 2); 1 mi. S Monterey on E side Munras Ave. (MVZ 3/3); Pacific Grove (LMK 1, SNHM 4); 17-mile Drive property, near entrance to Pacific Grove (MVZ 1/1). *San Benito Co.*—Butts Ranch, 3,000 ft., 5 mi. NNE San Benito (MVZ 1); 15 mi. E Gonzales on road to San Benito (MVZ 1/1); 3.3 mi. SE State 156 on Fremont Peak Road out of San Juan Bautista (MVZ 4/4). *San Luis Obispo Co.*—6 mi. W (MVZ 2) and 5.3 mi. WSW, 1,150 ft., (MVZ 2/2) Atascadero.

Ensatina eschscholtzii eschscholtzii Gray

Ensatina eschscholtzii Gray, 1850:48, original description.
Plethodon ensatus Cope, 1867:167, part.
Plethodon oregonensis, Cope, 1869:100, part.
Plethodon eschscholtzii, Grinnell and Camp, 1917:132, part.
Ensatina eschscholtzii, Dunn, 1923*a*:39, part.
Ensatina croceator, Slevin, 1930:78, part.

Type.—Three specimens, "a, b, c. . . . Half-grown and young," in the British Museum, are mentioned by Gray (1850), but a specific individual is not designated as the type. The type locality is given as "California." This was later amended by Boulenger (1882) to "Monterey, California," but with no explanation accompanying the change. Through the courtesy of H. W. Parker of the British Museum of Natural History, I am able to present a photograph of the "types." On the basis of information provided by him regarding pigmentation of these individuals, it appears that Monterey or vicinity is correct as to the locality of collection. Mr. Parker notes that the register of the Museum indicates that the specimens were purchased from a Mr. Hartweg.

Description.—Adult uniformly reddish brown to brown above, without pattern or with vague light or dark blotching;[8] upper eyelids pinkish, orange, buff, or less commonly brownish, usually lighter than dorsal ground color, with few or no melanophores; tail often with irregular distribution of melanophores dorsally, particularly toward tip, resulting in varying degrees of vague orange blotching; dorsal melanism ends in rather abrupt irregular line alongside of head, body, and tail, about on a level with dorsal surfaces of basal portions of limbs; lipophores extend somewhat farther ventrally forming fringe of pale orange-red beyond darker coloration; ventral surfaces of head, body, and tail usually whitish, in some individuals entirely without lipophores or melanophores; when melanophores are present, they usually occur sparingly on chin, in postgular region, and about vent; pleuroperitoneum without melanophores except at base of mesenteries and in vicinity of large blood vessels; lipophores sometimes present ventrally, coloring undersurfaces of limbs and tail pale orange-red, but never covering body and gular region; proximal

[8] Some individuals from the San Gabriel and San Bernardino mountains of southern California are dark blotched, in a manner suggestive of the race *picta,* while animals farther south and at lower elevations may exhibit a reversal of this condition, having breaks in the melanic ground color.

segments of limbs above usually uniformly orange or reddish orange to elbow and knee but about one out of three individuals with some melanism of distal portions; distal segments usually with mottling of melanophores on reddish orange background but in some individuals melanism more uniform, resembling that of upper surfaces of body although usually somewhat lighter; under surfaces of limbs pinkish or white, particularly on proximal segments; feet whitish, with speckling of melanophores, least abundant on toes; iris uniformly dark brown; usually no guanophores in skin.

Color changes with growth.—Juvenile uniformly reddish orange above with weak development of melanin; orange coloration most intense on tail, in part due to reduced melanism; upper eyelids usually lighter than head; below white with pale pinkish orange color often present on underside of tail and limbs; a few melanophores usually present on tip of chin; proximal segments of limbs reddish orange above; distal segments mottled with melanophores on orange ground color; feet whitish; whitish guanophores on head (including upper eyelids), usually along sides of head from jaw angle on to neck, and on sides of body; also usually present, but somewhat less abundantly, on upper surface of body.

With growth, melanin becomes more pronounced, accompanied by darkening of upper surfaces of body and distal segments of limbs; pale orange coloration of ventral surface of tail and limbs may fade to whitish; guanophores become obscure.

Topotype.—In the absence of an adequate description of the type and lack of references in other descriptions to salient features referred to in this paper, a topotype is herewith described. Because the type locality lies in an area of intergradation, the account to follow does not agree fully with the foregoing general description.

Adult ♀, Mus. Vert. Zoöl. no. 41745, obtained by author, 1 mi. S Monterey, E side Munras Ave., Monterey Co., Calif. Dorsal surfaces of body and head Bay, tail Chestnut; dorsal melanophores extend to line connecting upper surfaces of limbs; upper surface of distal segments of limbs Auburn; all ventral surfaces pale Bittersweet Pink, except for narrow longitudinal band along ventral surface of tail which is Apricot Buff; ventral melanophores absent except for small irregular cluster in postgular area; dorsal surface of proximal segments of limbs and narrow transitional area between dorsal and ventral color along sides, Grenadine Red; sides of tail Bittersweet Orange; upper eyelids Salmon-Orange darkened by melanophores on inner half; feet orange above and below except for tips of toes which are whitish; left eye with single guanophore in upper iris, otherwise eyes dark brown; no guanophores visible in skin.

Diagnosis.—Absence of light-colored dorsal spotting and almost complete absence of ventral melanophores distinguish *eschscholtzii* from races *platensis, croceator,* and *klauberi.* Distinguished from *picta* and *oregonensis* by scarcity of ventral melanophores and absence of guanophores in iris; further differs from *picta,* with exception of some individuals from Transition areas, in lacking dorsal dark blotches. Differs from *xanthoptica* in absence of yellow color

in upper iris and in having generally whitish, rather than orange, ventral surfaces and feet. Preserved specimens distinguished with difficulty from *xanthoptica* because of fading of diagnostic colors. Most reliable character is less extensive melanophore development on sides of body. In *eschscholtzii* these cells typically stop at or slightly above a line connecting the upper surfaces of the limb bases; in *xanthoptica* they usually extend well below this line.

In life, distinguished from all other races by combination of nonspotted dorsum, uniformly dark brown eyes, whitish ventral surfaces, and scarcity of ventral melanophores.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Head and body.—Melanophores of the dorsal surface of the head and body, throughout much of the range of the race, are largely uniformly distributed, appearing as stippling, as a close network, or as a combination of the two, depending upon the size of the animal, state of contraction of the cells, and locality of collection. Juveniles have less melanophore development than do adults, the latter nearly always exhibiting a heavy reticulum. The melanophores of very young animals may appear as stipple marks, although there is usually some reticulation on the back. Adult individuals exhibiting weak development of pigment come from San Diego County. The specimens from Sequoia Mine, Barber Mountain, in the collection of L. Klauber and the San Diego Society of Natural History, are notable in this regard. Occasional individuals from Los Angeles County and most animals from San Diego County have some breaks in the melanic ground color, giving a slightly mottled effect.

Tail.—Most individuals exhibit varying degrees of mottling of the dorsal and lateral surfaces of the tail due to irregular distribution of melanophores. This is true of all specimens (20) from San Diego County, 23 of 40 individuals from Los Angeles County and 4 of 5 animals from San Bernardino County. Animals from Ventura County (2) and one from Riverside County have uniformly colored tails. Two from Santa Barbara County are so marked but a third has a weakly mottled tail. There appear to be no sexual or age differences in this character. Geographic variation is present, the more southerly animals having the most pronounced mottling (table 9).

Sides.—Of 96 animals, 76 show melanophores limited by the limb line and 20 have melanophores extending below it. The majority (82 of 93) have an abrupt break between the dorsal melanic coloration and the melanophore-free ventral surfaces, although there is usually some thinning out of the cells at this line and some areas free of melanophores, usually in the costal grooves. There appear to be no sexual or age differences in this character, but weak geographic variation is present. Seven specimens from Los Angeles and San Bernardino counties have pigment extending well below the line and 10 are intermediate between "even with and below." All are from the San Gabriel and San Bernardino mountains, from higher elevations than other *eschscholtzii* studied (table 10).

Upper eyelids.—Most individuals possess light-colored upper eyelids that stand out in contrast to the darker pigmentation of the head, although rarely are they completely without melanophores. Of 76 animals, over half (43) have "slight" or less than "slight" development of melanophores. Sex and age differences do not appear to be present. There is weak geographic variation. Animals from San Diego County tend toward less melanism of the lids (as is true of the body generally) than those from the San Gabriel and San Bernardino mountains. Those from the Santa Monica Mountains, Los Angeles County, are intermediate (table 11).

TABLE 9

MOTTLING OF TAIL IN E. E. ESCHSCHOLTZII

County	Absent	Light	Medium	Great
Santa Barbara	1♂	1s	..	..
	1♀	..	..	..
Ventura	1♂	..	..	..
	1♀	..	..	..
Los Angeles	6j	6j	2j	3j
	3s	4s	1s	1s
	1♂	1♂	1♂	1♂
	7♀	1♀	1♀	1♀
San Bernardino	1s	..	2s	..
	..	1♂	..	..
	..	1♀	..	..
Riverside	1s	..	..	..
San Diego	..	1j	..	..
	..	..	6s	1s
	..	2♂	1♂	1♂
	..	..	5♀	3♀
Totals by age and sex	6j	7j	2j	3j
	5s	5s	9s	2s
	3♂	4♂	2♂	2♂
	9♀	2♀	6♀	4♀
Grand totals	23	18	19	11

Limbs.—Of 96 individuals, 65 (67.7 per cent) possess uniformly light-colored proximal segments of the limbs. Rarely, a few scattered or clustered melanophores are present. The remaining individuals show varying degrees of encroachment of the distal coloration of the limbs on to the proximal segments. Most of these have only a very slight intrusion of this pigment, but occasional animals may have close to half the segment so colored. Of 11 from the San Gabriel and San Bernardino mountains, 9 (82 per cent) have such heavily pigmented proximal segments.

In the character of the melanic pigmentation, the distal segments of the limbs grade from a rather weak mottled style of coloration to a moderately heavy and uniform one. All but two[9] animals from San Diego County and

[9] The exceptions are from Deer Horn Flat and Palomar Mountain.

many from the Santa Monica Mountains, Los Angeles County, are mottled; others from the Santa Monicas and one of two individuals from Ventura County are uniformly colored (table 12).

Ventral Surfaces.—All of 96 individuals are well below "slight" in development of ventral melanophores and 13 lack these cells completely. All classed as between "absent" and "slight" possess melanophores on the chin, from 4 or

TABLE 10

MELANOPHORES ON SIDES OF BODY IN E. E. ESCHSCHOLTZII

County	Above line connecting upper bases of limbs	I.c.*	Even with line connecting upper bases of limbs	I.c.*	Below line connecting upper bases of limbs
Santa Barbara	2s	..	..	..	..
	..	1♂	..	..	..
	1♀	..	..	..	..
Ventura	..	1♂	..	..	..
	..	..	1♀	..	..
Los Angeles	3j	10j	12j	6j	..
	1s	4s	3s	2s	3s
	..	1♂	5♂	..	1♂
	1♀	4♀	4♀	2♀	2♀
San Bernardino	..	..	..	..	3s
	..	..	..	..	1♂
	..	..	1♀	..	..
Riverside	1s	..	..	..	..
San Diego	2j	2j	..	..	..
	3s	2s	..	..	..
	1♂	2♂	..	..	..
	4♀	2♀	2♀	..	..
Totals by age and sex	5j	12j	12j	6j	..
	7s	6s	3s	2s	6s
	1♂	5♂	5♂	..	2♂
	6♀	6♀	8♀	2♀	2♀
Grand totals	19	29	28	10	10

* Intermediate category.

5 cells to numbers great enough to cloud most of the outer margin of the lower jaw. In addition, they appear in small numbers in other places, most commonly in the postgular area and about the vent. The gular, pectoral, and pelvic regions are almost always unmarked. One individual has a single melanophore in the pectoral area. Rarely, melanophores appear on the underside of the tail. At least two of the four animals so marked have regenerated tails. Occasional individuals are marked with a few scattered, occasionally clustered, melanophores on the body between the limbs.

No sex or age differences or geographic gradient appear to be present in the number and arrangement of these cells (table 13).

Pleuroperitoneum.—Of fifty individuals, all are essentially without melanophores in the lining of the body cavity. However, some of these cells usually

TABLE 11

MELANOPHORES OF UPPER EYELIDS IN E. E. ESCHSCHOLTZII

County	Absent	I.c.*	Slight	I.c.*	Medium	Between medium and great	Mottled
Santa Barbara	..	..	2s	..	..	..	..
	..	..	..	1♂	..	..	..
	1♀	..	..	..	..	..	..
Ventura	1♂	..	..	..	..	..	..
	..	1♀	..	..	..	..	..
Los Angeles	..	1j	8j	5j	4j	1j	..
	..	1s	5s	3s	..	..	..
	..	..	1♂	4♂	..	..	..
	..	..	1♀	6♀	2♀	..	..
San Bernardino	..	..	..	1s	1s	1s	..
	..	..	..	..	..	1♂	..
	..	..	..	..	..	1♀	..
Riverside	..	..	1s	..	..	..	..
San Diego	..	..	4j	..	..	..	..
	..	4s	1s	..	..	..	..
	1♂	..	3♂	..	..	..	..
	2♀	4♀	1♀	1♀	..	..	1♀
Totals by age and sex	..	1j	12j	5j	4j	1j	..
	..	5s	9s	4s	1s	1s	..
	2♂	..	4♂	5♂	..	1♂	..
	3♀	5♀	2♀	7♀	2♀	1♀	1♀
Grand totals	5	11	27	21	7	4	1

No individual was classed as having great development of melanophores of the upper eyelids.
* Intermediate category.

TABLE 12

MELANOPHORES OF LIMBS IN E. E. ESCHSCHOLTZII

County	Light coloration extending to elbow and knee	Light coloration stopping short of elbow and knee
Santa Barbara	2s	....
	1 ad.	1 ad.
Ventura	1 ad.	1 ad.
Los Angeles	21 j	6 j
	7s	5s
	11 ad.	11 ad.
San Bernardino	....	3s
	....	2 ad.
Riverside	1s	....
San Diego	7 j	....
	14 ad.	2 ad.
Totals by age	28 j	6 j
	10s	8s
	27 ad.	17 ad.
Grand totals	65	31

appear in the dorsal mesentery in the vicinity of the large blood vessels and in the pleuroperitoneum in a narrow zone on either side of it. Occasional individuals possess a sparse scattering of melanophores along the ventral midline but none has them in the lining of the lateral walls of the body cavity.

LIPOPHORES

These cells occur along with the melanophores on the dorsal surfaces, although they are usually scarce in the metapodial regions and are typically absent on the toes. They form the reddish orange color of the proximal segments of the limbs and contribute to the buff, pink, or yellowish orange of the upper eyelids. They extend a variable distance beyond the melanic color of the dorsum, forming a fringe of reddish on the sides where, occasionally, they may be irregular in distribution, particularly between the limbs. An individual from the San Bernardino Mountains, near the headwaters of the San Gorgonio River, was so marked. This animal had the melanophores reduced in number where lipophores were abundant.

In some individuals, lipophores are present on the underside of the tail and limbs, imparting a reddish orange coloration. In such animals, viewed from below, a narrow margin of lipophores can usually be seen on the sides of the abdomen and head, but an individual with these cells extensively distributed over the ventral surfaces, as in *xanthoptica* and *oregonensis,* has not been observed. Among the many examined, only one had two small clusters of lipophores centrally on the abdomen. Many appear to lack ventral lipophores entirely.

The color of the lipoid pigment varies. In most animals I have examined from the San Gabriel and San Bernardino mountains, it is much less intense than in individuals from generally lower elevations in the Santa Monica Mountains. This is well shown by the color of the dorsal surfaces of the proximal segments of the limbs which in the former has been identified as Flesh-Ocher, Orange-Vinaceous and Salmon-Orange and in the latter as Bittersweet Orange and between Bittersweet Orange and Grenadine Red.

GUANOPHORES

These cells do not appear to be present in adults. Most juveniles, however, have them in varying numbers, particularly on the upper eyelids and dorsal surface of the head. They become rapidly less numerous posteriorly, the pelvic region and tail seldom possessing them. A few may be present on the sides of the head, neck, and body between the limbs. Occasionally some may appear in the gular region. In all individuals examined by me, their color has been white or pale blue. With increase in size they rapidly disappear or become obscure. The patch situated beneath the network of lipophores of the dorsal surfaces of the proximal segment of the limbs, characteristic of other races, has not been detected in *eschscholtzii*. Possibly it does not occur. Guanism of the iris is apparently nonexistent.

HABITAT

In the Upper Sonoran Life-zone, the author has observed *eschscholtzii* in large numbers in the Santa Monica Mountains, Los Angeles County, California.

TABLE 13

Ventral Melanophores in E. e. eschscholtzii

County	General abundance		Detailed distribution							
	Absent	Between absent and slight	Chin	Gular area	Postgular area	Pectoral region	Abdomen Scattered	Abdomen Clustered	Vent	Tail
San Diego	....	6j	6j	....	2j	....	....	1j	3j	....
	1s	2s	2s	....	....	....	....	....	....	....
	2♂	4♂	4♂	....	1♂	....	....	....	....	....
	2♀	4♀	4♀	....	....	....	....	3♀	2♀	1♀
Santa Barbara	2s	....	....	....	....	....	....	....	....	....
	1♂	....	....	....	....	....	....	....	....	....
	....	1♀	....	....	1♀	....	....	....	....	....
Los Angeles	4j	25j	25j	....	3j	1j	3j	....	4j	....
	1s	14s	14s	1s	2s	....	2s	....	....	....
	....	7♂	7♂	....	....	....	1♂	....	....	1♂
	....	12♀	12♀	....	1♀	....	....	1♀	....	1♀
San Bernardino	....	3s	3s	....	....	....	1s	....	....	1s
	....	1♂	1♂	....	....	....	....	....	....	....
	....	1♀	1♀	....	....	....	1♀	....	....	....
Riverside	....	1s	1s	....	....	....	....	....	....	....
Ventura	....	1♂	1♂	....	....	....	....	....	....	....
	....	1♀	1♀	....	1♀	....	1♀	....	1♀	....
Totals by age and sex	4j	31j	31j	....	5j	1j	3j	1j	7j	....
	4s	20s	20s	1s	2s	....	3s	....	....	1s
	3♂	13♂	13♂	....	1♂	....	1♂	....	....	1♂
	2♀	19♀	18♀	....	3♀	....	2♀	4♀	3♀	2♀
Grand totals	13	83	82	1	11	1	9	5	10	4

No individual was classed in any of the categories, slight, medium, and great (see p. 389) nor did any individual possess melanophores in the pelvic region.

Individuals have been procured also at Newhall in the Santa Suzana Mountains and Harbison Canyon in southern San Diego County. At a number of places in the San Gabriel and San Bernardino mountains the race has been taken in the Transition Zone. A representative site from each zone is described below.

Upper Sonoran Life-zone.—Madelia Canyon, 900–1,100 ft., Sherman Oaks, Santa Monica Mts., Los Angeles Co., Calif. (pl. 16). One hundred and forty-six individuals were found by the author in this canyon during a period of slightly over one year. Although near-by canyons were searched, this one proved by far the most favorable for study. Salamanders were found beneath pieces of shale and logs and in leaf mold and rodent burrows, usually along the canyon bottom.

The canyon drains toward the San Fernando Valley to the north. Although it slopes about 45° for the first 200 yards below its divide, it soon levels off, sloping gently toward the valley. Its sides are steep, often over 45°, and its bottom narrow, seldom more than a few feet wide. Numerous, deep, tributary canyons open into its moderately sinuous course.

There is no stream, although in winter and spring, following storms, water may flow in the main canyon for several days, when the prevalent spongelike leaf litter has become well soaked.

The country rock is shale, mostly of a white, powdery, diatomaceous type, although occasional strata are dense, hard, and brown or buff in color. A dark-colored layer of soil, rich in humus, overlies the shale for a depth of over a foot in many places. Four or five inches of leaf litter is usually present on top of this layer. In many places erosion has exposed the shale, fragments of which have weathered out, littering the canyon bottom.

The hills are covered with chaparral, dominated by chamise (*Adenostoma fasciculatum*) and wild lilac (*Ceanothus macrocarpa*). Black sage (*Salvia mellifera*), white sage (*Salvia apiana*), California sagebrush (*Artemisia californica*) and buckwheat (*Eriogonum fasciculatum*) are other common chaparral plants. Clumps of sugar bush (*Rhus ovata*) and laurel sumac (*Rhus laurina*) are scattered among the more abundant chamise and *Ceanothus*. Conspicuous trees are wild black walnut (*Juglans californica*) and coast live oak (*Quercus agrifolia*), which are most common on north-facing slopes and in the canyon bottoms. Poison oak (*Rhus diversiloba*), maidenhair (*Adiantum* sp.), and brake fern (*Pteridium aquilinum*) and moss are found abundantly in shadier locations. Grass is widely distributed except beneath the denser chaparral. It is common in the canyon bottom beneath the live oaks and walnuts.

Transition Life-zone.—1½ mi. NW entrance Big Pines Recreational Camp Headquarters, 6,500 ft., Los Angeles Co., Calif. The mountains in this region are characterized by rather barren, often loose, soil with little humus or understory vegetation. A rather sparse forest, principally of pine, fir, and black oak is present.

An individual was found on a 30° northeast-facing slope, 50 feet from the bottom of a northwest-southeast-oriented canyon. No stream was present al-

though water flows in the canyon after rains and with the melting of snow in the spring. The salamander was discovered beneath a white fir log (25′ × 1′), one with most of its bark peeled off. The log lay at a right angle to the slope. Leaf litter was thin, consisting principally of white fir needles and black oak leaves. The soil was blackish and quite damp. Many other logs and rocks were scattered about. At the collection site, the dominant trees were white fir (*Abies concolor*) and black oak (*Quercus kelloggii*) with a few yellow pines (*Pinus ponderosa*). Young firs constituted most of the understory vegetation. Two other individuals, found separately under logs, also were taken in the area. The animals were found on May 2, 1946.

DISTRIBUTION

Eschscholtzii is probably primarily a race of the Upper Sonoran Life-zone, although the animals are widely, though apparently sparingly, distributed in the Transition Zone in the San Gabriel and San Bernardino mountains of southern California. It is to be expected in Transition areas elsewhere in the southland. Altitudinally, it is known to range from 700 feet in Harbison Canyon, San Diego County, to 6,500 feet in the San Gabriel Mountains at Big Pines, Los Angeles County.

Geographically it is known, at present, to extend from southern San Luis Obispo County southward in the coastal mountains to extreme southern San Diego County and to the southeast through the San Gabriel and San Bernardino mountains to Forest Home, San Bernardino County. A specimen from Indian Canyon in the western foothills of the San Jacinto Mountains indicates that the race occurs interiorly to the coastal mountains in Riverside County. To the north, animals from Pecho Ranch near San Luis Obispo, San Luis Obispo County, are considered to be of this race, with intergrades with *xanthoptica* appearing near Atascadero. To the south, the subspecies may extend into Lower California. A search should be made for the animals in the San Pedro Mártir Mountains.

From the occurrence of *Batrachoseps* on the islands off the coast of southern California and the recent report by Hilton (1945) of *Aneides lugubris* on Santa Catalina Island, it appears likely that *Ensatina* may also be of insular occurrence. The ranges of these three genera in California parallel each other closely.

Locality records.—CALIFORNIA: *Los Angeles Co.*—1½ mi. S Newhall, 1,500 ft.; 25 mi. NE junction State 2 and 118 (MVZ 1/1); Bailey Canyon, Sierra Madre, 2,500 ft. (MVZ 1); Tunnel in Bailey Canyon (MVZ 1); Sierra Madre, 2,600 ft. (2); Palmer's Canyon near Pomona (Storer, 1925:110); Soldier Creek, 5,300 ft., ¼ mi. S Crystal Lake Public Camp (MVZ 1/1); Pine Flats, San Gabriel Mountains (Bogert, 1930:4); Coldbrook Camp, San Gabriel Mountains (RBC 1); Millard's Canyon [near Pasadena] (Bogert, 1930:4); Big Santa Anita Canyon;[10] ½ mi. NW entrance to Big Pines Recreational Camp Headquarters, 6,500 ft. (MVZ 3/3); Los Angeles (CAS 1); Griffith Park, Los Angeles (USNM 1); Verdugo Canyon, near Glendale (AMNH 1); Topanga Canyon, Santa Monica Mountains (Rüthling, 1915); Van Nuys[10]; Madelia Drive Canyon, 900–1,100 ft., Sherman Oaks, Santa

[10] Localities for specimens in the collection of Los Angeles City College, provided by S. F. Wood. I have not checked on the identity of the animals upon which these records are based.

Monica Mountains (MVZ 64/64, also 84 marked and released in the field); Stone Canyon, 1,000 ft., Sherman Oaks, Santa Monica Mountains (MVZ 1/1). *Orange Co.*—Silverado Canyon, Santa Ana Mountains (Pequegnat, 1945). *San Bernardino Co.*—Quarry 10 mi. NW of San Bernardino (MVZ 1); Forest Home, 5,200 ft., San Bernardino Mountains (MVZ 2/1; 1 mi. SW Lake Arrowhead, Woodcraft Rangers' Camp, 5,374 ft. (MVZ 1/1); N tributary San Gorgonio River, 8.5 mi. N Banning, 6,000 ft. (MVZ 2/2). *San Diego Co.*—Palomar Mountain (5); between Rincon and back of Palomar Mountain (LMK 1); Suncrest (MVZ 1/1); Harbison Canyon, 1.8 mi. NE intersection at Dehesa, 700 ft. (MVZ 1/1); Deerhorn Flat, 2,400 to 2,500 ft. (LMK 1); Barrett Dam (LMK 1); Sequoia Mine, Barber Mountain, near Dulzura (SSNH 13, LMK 3, MVZ 2). *San Luis Obispo Co.*—Pecho Ranch, SW San Luis Obispo, about 2 mi. from seashore (MVZ 1/1). *Santa Barbara Co.*—8.5 mi. SE Lompoc (MVZ 4/4); Montecito district Santa Barbara;[11] Figueroa Mountain.[11] *Ventura Co.*—Sespe Canyon N Pine Creek (MVZ 2); Ojai;[10] Simi.[10]

In correspondence and conversation Dr. L. M. Klauber has expressed doubt regarding the accuracy of certain locality records for specimens from San Diego County loaned from his personal collection and that of the San Diego Society of Natural History. One of these is Sequoia Mine, Barber Mountain, near Dulzura from which over two dozen individuals presumably were taken. Three of these were obtained by W. Hynes on July 16, 1929, and the remainder a week or so later by an employee of the San Diego Zoo, E. E. Walker, who went in search of more specimens.

Klauber states (*in litt.*): "It is entirely possible that all of the specimens are authentic as to localities, but if any should show the slightest indication of having come from farther up state it would be the cause of no particular surprise to me. If my memory serves me, some time in the early 30's another expedition went out to Barber Mountain to locate the Sequoia Mine. They found an old mine tunnel which had mostly fallen in, but no salamanders. Whether this was really the Sequoia Mine and whether it was the place where Hynes and Walker got their specimens, I have no way of knowing."

I believe it likely that the "Sequoia Mine" animals are authentic as to locality data. Their pigmentation and their discovery in such numbers in the summer time (middle and late July) indicate first that they were obtained at the southern limits of the range (as now known) and second that they must have come from underground. A damp mine shaft would be a logical place, accessible to a collector in summer. All specimens, including those other than the "Sequoia Mine" series, possess much reduced melanophore development compared with that of animals farther north. This fits into the intergroup cline of decreasing melanism from north to south known to occur in the coastal races of *Ensatina*. The animals from San Diego County are the lightest so far observed. The locality—"Barber Mountain, near Dulzura," the presumed site of "Sequoia Mine"—lies at the southern extreme of the range and the specimens from this locality are the lightest in melanophore development of any studied. They resemble an individual collected by the author in Harbison Canyon, 10 miles in an air line northwest of Barber Mountain. I have visited the Dulzura region, including Deerhorn Flat and Barber Mountain. Although

[11] Localities reported to me by Margaret Irwin of the Santa Barbara Museum of Natural History. A photograph was seen of a Montecito specimen.

no *Ensatina* were found, there are many places in the oak-filled canyons that appear equally as favorable as Harbison Canyon.

SUBRACIAL DIFFERENTIATION

There is weak geographic differentiation in melanic pigmentation. Animals from San Diego County have the weakest melanophore development whereas those from the San Gabriel and San Bernardino mountains have the greatest, with the populations of the coastal mountains, north of the Los Angeles coastal plain, intermediate.

Storer (1929) called attention to the mottled style of coloration of two specimens of *eschscholtzii* from the San Gabriel and San Bernardino mountains. Fifteen individuals are now available from this area from both the Upper Sonoran and Transition life-zones. A comparison between them and *eschscholtzii* from other areas in southern California can now be made.

The mottled coloration is found in less than half of the animals (5), although when large numbers are available from the Transition Zone it may prove to be more common. They differ, however, in other ways from the more widespread coastal type. The melanophores are more widely distributed, extending laterally below a line connecting the upper surfaces of the limbs and occurring in greater numbers on the eyelids and proximal segments of the limbs, yet the cells seem to have less intracellular pigment than in the typical form. As based on 8 living individuals, the pigment of the lipophores is likewise less rich in hue, appearing as faded rather than bright orange. An adult female from Crystal Lake Park is almost without orange color—in coloration strikingly like the arboreal salamander, *Aneides lugubris.*

Possibly with more material critical analysis will reveal a mountain population sufficiently distinct to make application of a name desirable.

NOMENCLATURE

According to Boulenger (1882*b*), the type locality of the species, *E. eschscholtzii,* is Monterey. This locality lies in an area of intergradation between the two races, which in this paper I call *eschscholtzii* and *xanthoptica.* Although it is closer to the area occupied by *xanthoptica* (original description in this paper) than that inhabited by *eschscholtzii,* the species name is used to designate the southern race because the pigmentation of the animals from Monterey seems more strongly to favor the southern form.

Ensatina eschscholtzii picta Wood

Type.—University of California, Museum of Vertebrate Zoölogy, adult male, no. 27471, taken at Klamath, Del Norte County, California, November 4, 1933, by W. F. Wood.

Description.—Although Wood (1940) has characterized this race, it is desirable to include here a description in keeping with the style of color analysis employed elsewhere in this paper.

Picta is characterized by dark blotches on the body and tail. Although there is considerable variation in details of the markings, the general style of colora-

tion is constant. Significant variation is discussed beyond. In view of this uniformity, the following description of a topotype will suffice as the general color description of the race.

Topotype.—Adult ♀, MVZ 44034, 55.5 mm. in snout–vent length; collected 3 mi. N Klamath, Del Norte County, California, December 12, 1946, by W. F. Wood and J. Slevin. Ground color above is between Amber Brown and Argus Brown; dark dorsolateral markings blackish brown; sides of body mottled with Capucine Yellow; light-colored area on snout Salmon-Orange; ground color of tail Buff-Yellow, marked with Clove Brown; sides of tail Light Orange-Yellow; proximal segments of limbs above Deep Chrome basally, lightening to Light Orange-Yellow distally; ventral surfaces pale Orange-Buff with pinkish cast, resulting from presence of pale orange-yellow lipophores, scattered and somewhat irregular in arrangement in gular area but forming a rather uniform network elsewhere; melanophores distributed as a fine, rather uniform stippling over ventral surfaces; guanophores present in considerable numbers in breaks in melanic ground color dorsally and laterally—golden in color, probably due to overlying lipophores; guanophores scattered over all ventral surfaces except underside of tail, reduced on undersurfaces of limbs; eye patch diffuse, light Cadmium to Empire Yellow, occupying upper quarter of total area of iris; small patch in lower iris.

I cannot comment on color changes with growth as I have not seen living young. Alcoholics have markings similar to those of adults.

Diagnosis.—Distinguished from all other races except some *eschscholtzii* and young of *oregonensis* by small size and dark dorsal blotching. Differs from dark blotched *eschscholtzii* in having iridic guanophores and extensive melanophore development of ventral surfaces. Indistinguishable in general chromatic characteristics from young *oregonensis.*

ANALYSIS OF COLORATION: BLOTCHING

Wood (1940) has commented on the dark blotching, characteristic of *picta:* "The general style of coloration is remarkably constant, but, as is to be expected in spotted or blotched patterns, the details are variable. The tail is always mottled, black pigment nearly obscuring the yellow ground color in some specimens, or standing out in bold blotches against an equivalent amount of yellow in others. The dorsal and dorsolateral surfaces may be blotched or mottled with black. In a few animals the black pigment has no regular arrangement, but in most animals the black mottling, or a portion of it, forms an irregular or broken dorsolateral line.

"This line may be the only black marking on the dorsum . . . There may be a middorsal series of spots or blotches . . . A juvenile . . . has, on each side, in addition to the dorsolateral band, a continuous narrow black line from axilla to thigh.

"Specimens from Castle Rock, Crescent City Harbor, Del Norte County, California . . . , have the markings much reduced, the dorsolateral region being only slightly darkened, with faint blackish blotches posteriorly. The tails are characteristically mottled. Three specimens . . . from Whale Rock are typical *picta*, and indistinguishable from mainland Del Norte County specimens.

"With the exception of the insular series from Castle Rock, the 75 specimens available from Del Norte County are remarkably uniform and show but little significant variation."

I have little to add to this discussion except to direct attention to the distribution of individuals as classed according to standards established for this character, text figure 7, page 391, and text figure 8, page 396, showing the occurrence of *picta*-like blotching in *oregonensis* and *oregonensis-xanthoptica* intergrades.

It appears that nowhere in the range of the race are all the animals blotched. There always seem to be a few individuals that differ from *oregonensis* only in being of smaller size and in having larger eyes.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Aside from irregular distribution of dorsal melanin, *picta* closely resembles *oregonensis* in other aspects of the distribution of the melanophores. This includes the melanism of the eyelids, proximal segments of the limbs, ventral surfaces, and pleuroperitoneum.

LIPOPHORES

The distribution of ventral lipophores in adults resembles that of *oregonensis*. The ventral surfaces of limbs and tail usually have a uniform network, with the lipophores of the body often somewhat irregular in arrangement, and the gular area and chest frequently blotched or spotted. Presumably, juveniles resemble young of *oregonensis* in lacking or having only a few ventral lipophores except beneath the tail and limbs.

My casual impression has been that *picta* has somewhat heavier lipophore development than *oregonensis* from surrounding areas, but an objective analysis has not been made.

Lipophores, as in other coastal races, are important in the production of the tones of color of the dorsal and lateral surfaces of the body and limbs, particularly the proximal segments. Several color phases, resulting primarily from the color of the pigment of these cells, are observed. For example, near Orick, Humboldt County, where I recently obtained a series of these animals, of 20 adults, 7 tended toward orange, 8 toward buff-yellow, and 5 were lemon-yellow. Such variability is seen in *oregonensis* (pp. 398–399), in areas approaching the zone of *picta*, although apparently on a smaller scale.

GUANOPHORES

Skin.—In most adults, guanophores are scattered over the dorsal surfaces. They are usually present on the eyelids and head and in areas on the body and tail lacking dark blotches. Guanophores are usually reduced or absent over these markings. In some individuals, dorsal guanophores are few in number, particularly on the body. They are nearly always present in the light areas on the tail. Some usually occur distally on the limbs but the proximal segments typically have few or no superficial guanophores.

Guanophores are usually most abundant laterally. They form an irregular blotching and sprinkling on the sides of the head, neck, and body between the limbs; they are usually present basally on the tail but ordinarily become scarce distally. There is an irregular, deep, guanistic patch at the upper bases of the limbs below the lipophore network.

Picta has more extensive ventral guanophore development than other races. An irregular scattering of these cells is usually present on the abdomen and in the gular area. They are less common beneath the tail and limbs. They may occur individually or variously grouped in small clusters.

The guanophores margining the dorsolateral dark blotches and some of those elsewhere dorsally may appear golden in color, perhaps due to associated lipophores. Those on the sides and venter are usually white.

I cannot report on guanism of the young but probably it is like that of young *oregonensis*.

In general, *picta* resembles *oregonensis* in guanophore development of the skin and on the basis of this characteristic alone, some individuals are indistinguishable.

Iris.—The range of variation in the size of the guanistic patch in the upper iris is slightly less than that of *oregonensis* and the mean falls somewhat higher. *Picta,* on the average, tends to have a somewhat larger iris patch (text fig. 13, p. 481). It is often golden although it may be coppery, bronze, or greenish gold in color.

A smaller patch is nearly always present in the lower iris. This marking ranges from complete absence to a patch about ⅓ the area of the lower half of the iris.

DISTRIBUTION

In view of the gradual appearance, geographically, of the blotched style of coloration that characterizes *picta,* it is difficult to delimit the area inhabited by this race. I have nothing to add to Wood's (1940) statement of range which follows: "A narrow coastal area, from the vicinity of Weott, Humboldt County, California, northward through Del Norte County at least to Port Orford, Curry County, Oregon. The exact eastern limits are undetermined, but probably lie on the Pacific slope of the outer coast ranges."

Wood (1940) makes the following statements regarding areas of intergradation and geographic relationships between *eschscholtzii* (= *oregonensis*) and *picta:* "Toward the south, *picta* seems to intergrade with *E. e. eschscholtzii* [= *oregonensis*] in southern Humboldt County, as it also does to the east, along the Pacific slope of the outer coast ranges, as near Kneeland and Strong's Station, Humboldt County. Specimens from Carlotta seem referable to *picta,* intergradation presumably taking place between this locality and Strong's Station up the Van Duzen River, at an altitude between 1000 and 2600 feet. Two specimens (MVZ 14431, 14492) from South Fork Mountain near the Humboldt-Trinity County line are *E. e. eschscholtzii* [= *oregonensis*], and show no approach to *picta.* [I may add here that animals from Boise Creek, about 2 mi. W Willow Creek P. O., Humboldt County, California, are quite clearly intermediate between *picta* and *oregonensis.*]

"In Oregon, intergradation probably takes place just east of a similar narrow coastal strip. A specimen (MVZ 17160) from the Rogue River, 5 miles above Silver Creek, Curry County, is not definitely referable to *picta*. Other specimens which I have examined, from Linn, Jackson, and Tillamook counties, Oregon, seem to be *E. e. eschscholtzii* [= *oregonensis*], although they are rather different from California specimens of that subspecies.

"Specimens from points of intergradation are intermediate in coloration, usually having dark unicolored dorsa and mottled tails. In these areas one also finds animals which on an individual basis might be referred to either subspecies."

Owing to the difficulty in segregating individuals as intergrades, or typical *picta* or *oregonensis*, I include here only localities within the range as outlined by Wood. Animals from these areas show a high degree of development of dorsal blotching.

Locality records.—OREGON: Carpenterville (SCB 1); Harbor (CAS 1); Port Orford (CAS 3); Lobster Creek, about 1½ mi. W (SNHM 3, MVZ 4/4), also small creek ½ mi. W (SNHM 2), also ravine about 2 mi. W (SNHM 4), and W side, ½ mi. above its mouth, Rogue River Basin (SNHM 2).

CALIFORNIA: *Del Norte Co.*—Klamath (MVZ 13/3, CAS 10, CNHM 8), within ½ mi. (MVZ 1), 2 mi. E (CAS 3), 3 mi. N (CAS 5), 8 mi. N (CAS 8), and near Klamath (MVZ 3); N side Klamath River, just E of Terwah Creek (SNHM 2); Smith River (CAS 1); along Smith River 6 mi. E Crescent City (MVZ 4); Crescent City, 8 mi. E (AMNH 2), 6 mi. SE (CNHM 1), 8 mi. NE (CAS 5), Castle Rock, 3 mi. N (CAS 27), Whale Rock in harbor (CAS 3), and near Crescent City (UMMZ 1); Requa (CAS 3, USNM 6), 5 mi. SE (MVZ 3, CM 1), 6 mi. SE (CNHM 3), and 5 mi. E (CAS 2); Chaffey Ranch (SNHM 1); Mill Creek Park (CAS 55/1). *Humboldt Co.*—Orick (CAS 2), 5 mi. N (CAS 7), 12 mi. N (LMK 1); Prairie Creek, 5 mi. N (LMK 1, MVZ 1/1), 4 mi. N, 250 ft. (MVZ 25/25), and 4½ mi. N and 1½ mi. E, 100 ft. (MVZ 2/2).

INTERIOR SUBSPECIES

Ensatina eschscholtzii platensis (Espada)

Urotropis platensis Espada, 1875:71, original description.
Plethodon platensis, Boulenger, 1882*b*:55.
Ensatina platensis, Dunn, 1923*a*:37.
Ensatina sierrae Storer, 1929:30, original description.
Ensatina croceator, Slevin, 1930:78, part.

Type.—Adult female (?) in the Instituto José de Acosta, Museo Nacional de Ciencias Naturales, Madrid, Spain; date and locality of collection unknown, although at one time thought to have come from the vicinity of Montevideo, Uruguay. On the basis of the shape of the snout, tail length, and appearance of the vent, as shown by photographs of the type, I conclude it is a female.

Description.—Adult with variable number of reddish-orange spots on dorsum and sides of head, body, and tail; spots with irregular borders and of variable size, ranging from flecks which are scarcely visible to marks 3 mm. or more in diameter; upper eyelids spotted, often yellowish rather than orange; ground color dark brown dorsally, blending laterally with pale gray to whitish of ventral surface; ventral surfaces with stippling of melanophores; proximal

segments of limbs above yellowish orange to orange-red, lighter below; distal segments of limbs spotted like body but on a somewhat lighter ground color; toes and ventral surfaces of feet lighter than remainder of distal segments of limbs; digits faintly crossbanded with light color at joints; guanophores scattered, usually singly, over most of dorsal and lateral surfaces and sometimes sparingly on ventral surfaces; concentration of these cells usually present at base of each limb on upper side, forming patch of irregular shape beneath lipophore network as in *oregonensis*, *xanthoptica*, and *picta;* iris dark brown with or without silvery to gold guanophores in upper part; when present these cells occur in variable numbers from 2 (as based on present material) to network which fills most of upper iris; guanophores less common in lower iris.

Color changes with growth.—Juvenile nearly black above with obscure orange spotting or spotting absent; proximal segments of limbs yellow to yellowish orange; ventral surfaces dusky except for under surfaces of proximal segments of limbs which may be pinkish orange; dorsal and ventral colors grade gradually along sides of head, body, and tail; guanophores numerous on dorsal surfaces, particularly on head and body, less so on tail.

With growth, ground color becomes less intense black and may eventually assume a brownish cast; dorsal light spotting becomes more intense and reddish orange color of adult appears; all spots, including those on eyelids become better defined; more orange or reddish appears in color of proximal segments of limbs; ventral surfaces become lighter; guanophores become less apparent.

Diagnosis.—Differs from coastal races of *eschscholtzii* in presence of reddish orange spotting on dorsal and lateral surfaces of head, body, tail, and distal segments of limbs. Distinguished from southern blotched races *croceator* and *klauberi* in having smaller spots and in absence of large paired blotches or a transverse U-shaped band on head. Southern subspecies usually lack light spots on distal segments of limbs. Agrees with *klauberi* in reddish orange color of markings but differs in this regard from *croceator* which has yellow or cream-colored markings.

ANALYSIS OF COLORATION: SPOTTING

There is great diversity in size, shape, and number of dorsal spots. An attempt has been made first to measure the degree of spotting by assigning each individual to one of 7 standards, arranged in graded series (pl. 13, figs. 2 to 7), and secondly to study certain aspects of spotting, namely (1) the degree of development of light color on the eyelids, (2) the amount of light spotting on the distal segments of the limbs, and (3) the number, size, and shape of the spots in the parotoid areas.

Body and tail.—From table 14 (p. 436) it is seen that (1) there is no sexual dimorphism in the amount of dorsal spotting; (2) juveniles and subadults, on the average, show less well-defined spotting than do adults; (3) individuals from Fresno County and to a greater extent Tulare County tend toward large spots.

Development of spots in two juveniles from Fern Spring, Yosemite Valley, Mariposa County, was studied. When they were examined upon first bring-

TABLE 14

VARIATION IN DORSAL SPOTTING IN E. E. PLATENSIS

County	Pattern types (pl. 13, figs. 2–7)												
	1 (no spotting)	I.c.*	2	I.c.*	3	I.c.*	4	I.c.*	5	I.c.*	6	I.c.*	7
Tehama	....	1s	2s	....	....	....	1♂	....	....	....	....	....	....
Butte	....	1s	1♂	....	....	1♀	....	....	....	....	....	....	....
Sierra	....	....	....	....	....	1♀	....	....	....	....	....	....	....
Nevada	....	....	....	....	1s	....	....	....	....	....	....	....	....
El Dorado	....	....	1s 1♂	1s	1s	1♀	....	....	....	....	....	....	....
Calaveras	....	....	....	....	....	....	....	1♀	....	....	....	....	....
Tuolumne	....	2j	....	....	....	....	1♀	....	....	....	....	....	....
Mariposa	3j	1j	1s 2j	1s 1♀	....	....	1j	....	....	....	....	....	....
Madera	....	1j	....	....	1j	1♀	1♂	....	....	....	....	....	....
Fresno	....	....	2j	....	1s	....	....	2s	1s	1s	....	....	1s
Tulare	....	....	....	1♂	1j 1♂	2j	2s 1j 1♂	1j 5s 3♀ 4♂	2♂	1♂ 2♀	2♀	1♀	....
Totals by age and sex	3j	4j 2s	4j 4s 2♂	.... 2s 1♂ 1♀	2j 3s 1♂	2j .... 4♀	2j 2s 3♂ 1♀	1j 7s 4♂ 4♀	.... 1s 2♂	.... 1s 1♂ 2♀	.... 2♀	.... 1♀	.... 1s ....
Grand totals	3	6	10	4	6	6	8	16	3	4	2	1	1

* Intermediate category.

ing them to the laboratory, the dorsal spotting was obscure. Under magnification, the distribution of spots was mapped. At intervals throughout the following months, these individuals were examined and changes in the spots noted. It was found that (1) no distinctly new light areas appeared, that is, zones of light color did not form in areas without rudimentary spots; (2) closely knit clusters of small spots, which could be seen only with difficulty without a lens, united to form more definite blotches, and (3) the spots became richer in color. In assigning individuals to categories measuring degree of spotting, a majority of the young were placed in the lower classes due to the obscurity of the juvenal pattern.

Croceator, with which *platensis* intergrades in southern Tulare County and northern Kern County, generally possesses considerably larger spots in relation to body size than does *platensis*. Accordingly one finds individuals from Tulare County in the southern part of the range of *platensis* exhibiting a tendency toward large spots. Not only is there increase in size of the spots but their arrangement is also suggestive of *croceator*. Often they lie in two linear series, one on either side of the midline. The marks may alternate with one another, lie opposite each other, or their distribution may be irregular as is also true of *croceator*. Typical *platensis* tends toward an irregular arrangement of the dorsal spots. In these same areas, individuals showing the more typical pattern of *platensis* occur. Individuals from Sequoia National Park and vicinity have been segregated according to the race favored as to spotting. Twenty were examined of which 11 (1j ,3s, 1♂, 6♀) were classed as like *platensis* and 9 (1s, 6♂, 2♀) as resembling *croceator*.

Four of the *croceator*-like animals (1j, 2s, 1♀) from Sequoia have large paired or alternating blotches, ⅓ to almost ½ the width of the body, rounded or rectilinear. An adult female has rectilinear blotches which approach in size and form those of the race *klauberi* (pl. 13, fig. 8). The margins of the blotches are, however, quite irregular, whereas typical *klauberi* possesses blotches of more regular outline. The tabulation seems to suggest some sexual dimorphism in the size and arrangement of the dorsal markings in adults from Tulare County, males tending to resemble *croceator* more than females. However, perhaps more specimens would serve to eliminate this difference. No dimorphism is apparent farther north.

Upper eyelids.—Platensis possesses varied development of light coloration of the upper eyelids whereas *croceator* usually lacks such markings as judged by the 15 individuals available. Such color is rarely absent in *platensis*. All but one of 59 individuals (7j, 22s, 15♂ and 15♀) from localities extending from Tehama County to Tulare County have well-developed light marks on the lids. The exception is a juvenile from Tuolumne County. Juveniles and subadults tend to have less pronounced markings than adults, probably for reasons given in the discussion of dorsal spotting.

The marks are variable in form. They range from a single patch of light color that includes the entire lid and some of the adjacent skin of the head, through a condition with several well-defined and closely grouped spots, to one with a few minute flecks confined within the boundary of the lid. Some-

times a single spot smaller than the lid is present. Markings of the two lids vary independently. Animals from Tulare County show a tendency toward larger and better-defined marks.

Parotoid areas.—Owing to the presence in *croceator* of a single large blotch on the upper surface of the head in each parotoid area, a trend toward such

TABLE 15

VARIATION IN SPOTTING OF PAROTOID AREAS IN E. E. PLATENSIS

County	Pattern types (pl. 13, figs. 4, 9, 5)					
	None	I.c.*	Indefinite (fig. 4)	I.c.*	Grouped (fig. 9)	Definite blotch (fig. 5)
Tehama	1s	2s	1♂	..	..	..
Butte	1♂	1s	..	..	..	..
	..	1♀	..	..	..	..
Nevada	..	..	1s	..	..	..
Sierra	..	..	..	1♀	..	..
El Dorado	1♀	1s	1s	2♂	..	..
Calaveras	..	1s	..	1♂	..	..
Tuolumne	1j	..	1♀	1j	..	..
Mariposa	..	1j	1s	..	..	..
	..	2s	..	..	..	..
	..	1♀	..	..	..	..
Madera	..	..	1♂	1♀	..	..
Fresno	1j	..	2j	1♀	..	..
	..	..	5s	..	..	..
Tulare	..	..	7s	1j	..	..
	..	..	6♂	2♂	..	1♂
	..	..	1♀	1♀	3♀	3♀
Totals by age and sex	2j	1j	2j	2j	..	..
	1s	7s	15s	..	..	..
	1♂	..	8♂	5♂	..	1♂
	1♀	2♀	2♀	4♀	3♀	3♀
Grand totals	5	10	27	11	3	4

* Intermediate category.

markings in *platensis* was anticipated. The categories to which specimens were assigned are as follows: (1) no spots in the parotoid regions; (2) spots present but irregular in arrangement; (3) spots clustered, a group in each parotoid area; (4) a single large blotch in each parotoid area.

From table 15, it appears that some sexual dimorphism may be present in this character in the southern part of the range of *platensis*, for of 9 males and 8 females from Tulare County, 1 and 6, respectively, are classified as having parotoid markings grouped or in the form of a blotch. This tendency stands in contrast to that mentioned earlier (p. 437) for the body blotches,

in which adult males tend more toward a *croceator*-like pattern. If these sexual differences are upheld by study of additional material, then males in this area are closer to typical *croceator* pattern in size and arrangement of dorsal body spots whereas females are closer in parotoid markings.

Individuals with spots grouped or with parotoid blotches were found only in Tulare County.

TABLE 16

SPOTTING OF DISTAL SEGMENTS OF LIMBS IN E. E. PLATENSIS

County	Absent	I.c.*	Slight	I.c.*	Medium	I.c.*	Great
Tehama	2s	..	1s	..	1♂	..	..
Butte	..	1s	..	1♂	..	1♀	..
	..	..	..	1♀	..	..	..
Nevada	..	..	..	1s	..	..	..
El Dorado	..	..	..	1s	..	..	1s
	..	..	..	..	..	..	2♂
	..	..	..	..	..	..	1♀
Calaveras	..	..	1s	..	..	..	1♂
Tuolumne	..	1j	..	..	..	1j	1♀
Mariposa	..	..	1j	..	..	..	..
	..	..	1s	1s	1s	..	..
	..	..	..	..	1♀	..	..
Madera	..	..	..	..	1♂	..	1♀
Fresno	..	..	..	2j	1j	..	..
	..	..	..	1s	2s	1s	1s
	..	..	..	..	1♀	..	..
Tulare	1j	..	..	..	..	..	..
	1s	..	..	3s	2s	..	1s
	6♂	..	1♂	1♂	1♂	..	..
	4♀	..	2♀	..	1♀	1♀	..
Totals by age and sex	1j	1j	1j	2j	1j	1j	..
	3s	1s	3s	7s	5s	1s	3s
	6♂	..	1♂	2♂	3♂	..	3♂
	4♀	..	2♀	1♀	3♀	2♀	3♀
Grand totals	14	2	7	12	12	4	9

* Intermediate category.

Limbs.—There is varied development of light spotting of the outer surfaces of the distal segments of the limbs. Each individual was assigned to one of 4 categories: spotting (1) absent, (2) slight, (3) medium, and (4) great. Table 16 summarizes these data. Several facts are apparent from this analysis: (1) Sexual dimorphism is absent. (2) There is essentially no change with age. (3) With the exception of individuals from Tulare County, most animals have medium spotting. The animals from Tulare County lacking spotted limbs show an affinity with *croceator*, since this race has essentially uniformly colored distal segments of the limbs.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Limbs.—Of fifty-five individuals, all but 4 possess essentially uniformly light-colored proximal segments of the limbs. The exceptions have a slight encroachment of the dark color of the distal segments on to the proximal elements,

TABLE 17

VENTRAL MELANOPHORES IN E. E. PLATENSIS

County	Absent	I.c.*	Slight	I.c.*	Medium	I.c.*	Great
Tehama	..	..	..	1j	2j	..	..
	..	..	..	1♂	..	..	..
Butte	..	..	..	..	..	1s	..
	..	..	..	..	..	1♀	
	..	..	..	..	..	1♂	..
Nevada	..	..	..	..	..	..	1s
Sierra	..	..	..	1♀	..	..	..
El Dorado	..	..	..	..	1♂	3s	..
	..	..	..	..	..	1♀	..
Calaveras	..	..	..	1♀	..	1s	..
Tuolumne	..	..	..	..	1j	1j	..
	..	..	..	..	1♀	..	..
Mariposa	..	..	..	..	1j	1j	3j
	..	..	..	1s	1s	1s	..
	..	..	..	..	..	1♀	..
Madera	1♂	..	..	1♀	..	..	3j
Fresno	..	..	..	3s	3s	1j	..
Tulare	..	..	..	2j	..	1j	..
	..	..	..	5s	3s	..	..
	1♀	2♀	2♀	3♀	..	..	..
	1♂	..	3♂	2♂	2♂	..	..
Totals by age and sex	..	..	..	3j	4j	4j	6j
	..	..	..	9s	7s	6s	1s
	2♂	..	3♂	3♂	3♂	1♂	..
	1♀	2♀	2♀	6♀	1♀	3♀	..
Grand totals	3	2	5	21	15	14	7

* Intermediate category.

extending about ¼ to ⅓ the distance toward the limb base. *Platensis* is intermediate between *klauberi*, to the south, which usually has light color extending beyond the elbow and knee, and *oregonensis*, to the north and west, which typically has light color stopping short of the elbow and knee.

Ventral surfaces.—Variation in ventral melanophore development is shown in table 17. Several facts are apparent: (1) There is no sexual dimorphism. (2) Most individuals are classed between slight and medium. (3) There is no indication of a north-south gradient.

Subadults and particularly juveniles were frequently classed as having

heavy melanophore development. Some individuals were probably erroneously segregated because the large size of the melanophores in relation to body size and the close arrangement of the cells in young animals gives one a spurious impression of heavy pigmentation. The melanophores of the young, although similar in size to those of the adults, are proportionately much larger. It is possible that their number and distribution change but little from birth and that lightening with growth mostly results from an increase in the extent of surrounding tissues. The melanophores of adults are much more widely spaced than those of juveniles.

A considerable number of adult males and females from Tulare County have slight melanophore development and a few lack melanophores entirely. *Platensis* intergrades with *croceator* in other characters in southern Tulare and northern Kern counties, but a difference between the ventral melanism of *croceator* and that of *platensis* has not been noted. The explanation for reduced stippling in specimens from this area is not apparent. It may be due to gene interactions in the intergrading area or it may be a local gene difference.

In many individuals the distribution of melanophores is nearly uniform but there is often thinning on the pelvis, chest, and posterior gular area. Melanic stippling may be reduced also on the underside of the tail, proximal segments of the limbs, about the vent, and sometimes along the midline of the body. Melanophores are frequently concentrated anteriorly in the gular area, about the margin of the lower jaw, and in the postgular region.

Melanophores may be unconnected, appearing as distinct specks, or less commonly (in preserved material at least) they may form a reticulum, depending upon their abundance and state of contraction. Glandular areas appear as light-colored circular zones in the network. A reticulum is more often present in juveniles than in older animals. Progressively larger individuals show increasingly less reticulation. The juvenal network is due to closer approximation of the melanophores and possibly a difference in movement of pigment granules within the cells. The branches of the cells are nearly always filled with pigment, whereas in adults the pigment is concentrated in the cell reservoir causing the cells to appear as black dots with few branches showing. Perhaps changes in action of melanophores occur with maturation. Most specimens were preserved in the same manner, that is, by drowning in formalin.

Pleuroperitoneum.—Melanophores are present in the lining of the body cavity. These cells approximate in abundance the same kind of cells on the ventral surface of the body. The number of animals studied arranged by county are: Tehama, 2; Butte, 1; El Dorado, 1; Mariposa, 3; Madera, 2; and Tulare, 7. No differences correlated with age or sex are apparent. In this characteristic, *platensis* is similar to adjoining races—*oregonensis* and *croceator*—with which it intergrades.

LIPOPHORES

These cells are largely responsible for the color of the dorsal spots, characteristic of this race and, for the most part, the color of the proximal segments of the limbs. From the living material available to me (11 individuals), lipophores appear to be absent ventrally except for the lower surfaces of the limbs.

GUANOPHORES

Skin.—In general, there is a heavy sprinkling of these cells over nearly all dorsal surfaces in young individuals but gaps in their distribution may occur dorsolaterally. The guanophore-free areas are arranged much like the dorsolateral dark blotches of the race *picta*. In the distribution of guanophores, juvenal *platensis* closely parallels *picta* because this race similarly lacks guanophores in the dorsolateral dark-blotched zones or has them considerably reduced. Is the guanophore distribution of young *platensis* reminiscent of an ancestral pattern? Guanophores usually are present in greatest numbers on the head, including the upper eyelids, and become less abundant posteriorly; they are seldom discernible superficially on the proximal segments of the limbs and are usually scarce on the distal segments and on the tail. They are rarely present on the ventral surfaces although occasionally a few may occur, most often in the gular region. There is progressive reduction in number with increase in size, and adults may almost completely lack them. It is suspected that with abundant material, a north-south gradient could be shown in this character, the more southerly animals having reduced guanism. This is inferred from the change that takes place in the same character in coastal populations of *Ensatina* and the fact that adult *platensis-oregonensis* intergrades have marked guanophore development, whereas to the south the spotted forms, *croceator* and *klauberi*, have few guanophores or lack them completely.

The color of the guanophores is silvery or pale blue. Both colors may appear in one individual. The bluish cells appear to be more superficial in position and the color differences are probably due to interference phenomena.

A patch of closely set guanophores forms a cluster of irregular shape and variable continuity at the dorsal bases of the limbs. This patch is overlaid by the lipophore network of the proximal segments of the limbs.

Iris.—Guanism of the iris is seldom strongly developed and may be totally lacking. The best-defined patch observed among 8 individuals studied consisted of a diffuse cluster of these cells, occupying about a quarter of the total area, located centrally in the upper portion of the iris. Two individuals (ad. ♀, Mineral, Tehama County, and ad. ♀, Yosemite Valley, Mariposa County) lacked iridic guanophores, entirely. The remainder stood between the two extremes. Occasionally a few guanophores are present in the lower iris. The iridic guanophores may be silvery, copper, or golden.

HABITAT

150 yds. SW Indian Caves, 4,000 ft., Yosemite Valley, Mariposa Co., Calif. Adult ♀, Mus. Vert. Zoöl. no. 42052, collected by author, July 5, 1945. The salamander was found on level ground in a shaded area beneath a well-embedded log 3 feet in length and 8 inches in diameter that lay with only its upper surface exposed. The log rested against damp, black, sandy loam in which there were some fragments of decayed wood. Its sides were covered by the surface debris which was about 4 to 6 inches thick, composed principally of black cottonwood and incense cedar leaves mingled with twigs and larger

branches. Beneath the log a number of interlocking sticks formed channels into which the salamander might have retreated. The log split upon lifting and the interior was found to be soggy. An earthworm was the only other animal seen. Vegetation in the vicinity consisted predominantly of incense cedar (*Libocedrus decurrens*) and black cottonwood (*Populus trichocarpa*) with yellow pine (*Pinus ponderosa*) in drier places. Young incense cedars were scattered about among brake fern, enchanter's nightshade (*Circaea pacifica*), cow parsnip (*Heracleum lanatum*), bed straw (*Galium trifolium*), and grasses. The area suggested a transitional stage in the replacement of a damp grassy meadow by mesic plants with the more xeric types, yellow pine and black oak, as the climax vegetation.

The site of collection was situated about 200 feet to the north of a stream which is a tributary of the Merced River. At the time of collection (7 :15 a.m., P.W.T.), the area was in the shadow of the mountain mass at the east end of the Valley and would not have been illuminated for several hours.

Fern Spring, 3,800 ft., Yosemite Valley, Mariposa Co., Calif. Three juveniles (MVZ 42053 and RCS 94 and 96) collected July 9 and 10, 1945. Fern Spring is on the floor of Yosemite Valley, on the southwest side of the highway about 1 mile northwest of Bridalveil Fall, about 200 feet southwest of Merced River. The spring is of clear, cold water, restrained by a semiartificial bowl of granite boulders. The overflow passes beneath the highway and thence down a fern-covered slope to the river. The water issues from the base of an extensive talus of granite boulders which appears to have been in repose for a considerable period, for at present there are no rocks which do not exhibit a rather uniform growth of a small dark lichen that blackens all exposed surfaces. Rangers in the area state that at least 15 years are required for the development of this black coloration. In addition, in shadier places the rocks are covered with larger varieties of lichen and with moss. There is little herbaceous cover. The talus immediately above the spring lies at an angle of 30 to 35° and faces to the northeast.

The spring and the slope above it are well shaded by white fir (*Abies concolor*), incense cedar, mountain dogwood (*Cornus nuttallii*), maple (*Acer macrophyllum*), and stream alder (*Alnus rhombifolia*), concentrated within a radius of several hundred feet about the spring. In the vicinity of the spring and on the slope below on the northeast side of the highway, are ferns, a yellow *Mimulus* (blooming), enchanter's nightshade, bed straw, horsetail (*Equisetum* sp.), and grasses.

The surface of the talus is dry, with little decomposing material except about rotting trees. Boulders with numerous exposed interstices among them are abundant. Although at this time the general aspect of the area, apart from a zone immediately about the spring, is one of dryness, nevertheless the interiors of the larger logs are so moist that water can be squeezed from the punky interiors as from a sponge and the rotting litter at the sides of downed trees is damp just under the surface.

On July 9 two juveniles were obtained 100 yards southwest of the spring, well up on the talus. The first individual was found upon removal of a piece

of weathered heartwood from the side of a large decayed incense cedar log 30 feet long and 3 feet in diameter. The log lay with its long axis parallel to the angle of the slope, with its lower third buried in decomposing bark and leaf litter. The site was shaded by a close growth of dogwood, incense cedar, and white fir, scattered young trees of which formed the principal ground cover.

The second individual was found 4 feet away, when a badly decomposed log (probably incense cedar) was dismembered. The log lay parallel to the first, about half as long, with its upper surface almost level with the surrounding litter. The disintegrating wood was broken up into numerous rectilinear blocks of varying size, most pieces measuring about 2 inches on a side. The salamander was found in the space between two such blocks, at a depth of about 3 inches. The site of collection for both individuals was only moderately damp. Water could not be squeezed from the decayed material.

On July 10 a third juvenile was found in a place similar to those occupied by the animals collected on July 9. It was found in decomposing material along the side of a large incense cedar log.

Other animals observed in the litter were: scorpions, millipedes, centipedes, ants (several species), carabid beetles, and silverfish.

DISTRIBUTION

Platensis is largely confined to the Transition and Upper Sonoran life-zones of the western slope of the Sierra Nevada, from northern Tehama County south to southern Tulare County, California, near the juncture of the Sierra and the Tehachapi Mountains. Search should be made for the animals on the eastern slope of the Sierra and in the mountains to the east. This race, or a close relative, may occur in the White Mountains and possibly on Telescope Peak, west of Death Valley, California.

Platensis intergrades with *oregonensis* in northern California and southwestern Oregon and with *croceator* in the Kern River drainage. To the north, as based on present material, the first intergrades with *oregonensis* appear in the vicinity of Burney, Shasta County. To the south individuals from White River and Quaking Aspen Meadow in Tulare County, and Kern County Park and the Piute Mountains in northern Kern County, California, are considered as intergrades.

In altitude, the race is known to range from 1,650 feet, 1 mile east of Cohasset, Butte County, to 8,600 feet, 2 miles west of Hockett Meadows, Sequoia National Park, Tulare County. The first locality is in the Transition, the second in the Boreal Life-zone. That the race enters the Upper Sonoran Zone is indicated by an individual that was found at Flume Truck Trail, 2,140 feet, in Sequoia National Park, where chaparral and live oaks (*Quercus wislizenii*) predominated. Most localities, however, are in the Transition Zone where the animals are probably most abundant.

Locality records.—CALIFORNIA: *Butte Co.*—De Sabla Power House (SNHM 1); Magalia Dam near Chico (SNHM 1); 1 mi. E Cohasset, 1,650 ft. (RCS 1/1); Paradise (MVZ 1/1). *Calaveras Co.*—Mokelumne Hill (Slevin, 1928); Calaveras Big Trees (CAS 2). *El Dorado*

Co.—Park Creek (MVZ 2/2); Strawberry Valley (CAS 1); near Grizzly Flats (1); Snowline Camp (MVZ 3/3); Fyffe (SNHM 5); Sly Park (Storer, 1929). *Fresno Co.*—Dalton River, 5,000 ft. (MVZ 1); Lake Sequoia (MVZ 4); General Grant National Park (MVZ 2). *Madera Co.*—Boggy Meadows (MVZ 1); Northfork, Malum Ridge, 3,000 ft. (MVZ 5); Southfork, near Northfork, 3,000 ft. (MVZ 2); Bass Lake, 3,500 ft. (PB 3/3). *Mariposa Co.*—At the following places in Yosemite Valley, at or near 4,000 ft.: Indian Village (YM 1); Camp 19 (YM 2); Yosemite Valley [no specific locality] (YM 2, CAS 2); base of Glacier Point (MVZ 1); vicinity of Fern Spring (MVZ 3/3, YM 1); 100 yds. SW Indian Caves (MVZ 1/1); Tenaya Canyon (USNM 1). Other localities are: Merced Canyon (MVZ 2); forest above Big Meadows (YM 1); near Dewey Point, S rim Yosemite Valley, 7,300 ft. [type locality of *Ensatina sierrae* Storer (1929)] (MVZ 4); Wawona Meadows, 4,000 ft. (YM 1); Mariposa Grove, 6,000 ft. (YM 1). *Nevada Co.*—About 4 mi. S North San Juan, 2,000 ft. (MVZ 1/1); Nevada City (MVZ 1/1). *Placer Co.*—Alta, 3,600 ft. (Grinnell and Camp, 1917). *Sierra Co.*—15 mi. N Downieville (MVZ 1). *Tehama Co.*—Lassen Volcanic National Park Headquarters, 2 mi. E Mineral, 5,200 ft. (MVZ 1/1); Turner's, Lyonsville P. O., 3,500 ft. (MVZ 2). *Tulare Co.*—In Sequoia National Park: Kaweah Colony Mill, White River, and Giant Forest (Slevin, 1928); Giant Forest, 6,800 ft. (MVZ 2); Flume Truck Trail, 2,140 ft. (MVZ 1); Crescent Meadow (SNHM 3); 2 mi. W Hockett Meadows, 8,600 ft. (MVZ 1); Heather Lake Trail (LAM 2); Sequoia National Park (no specific localities) (MVZ 1, CAS 14); Mud Spring, 4 mi. W Nelson, 6,300 ft. (MVZ 3); Round Meadow (MVZ 1); Whitaker's Forest, 10 mi. NE Badger (MVZ 1). *Tuolumne Co.*—⅛ mi. S Carnegie Institution Gardens, Mather (AMNH 2); Tiltill Trail, 1½ mi. from Hetch Hetchy, 6,000 ft. (YM 1); Miguel Meadows, 5,200 ft. (YM 1); Strawberry, Sonora Pass (SNHM 1); Groveland, 6 mi. ESE (MVZ 1/1), 1.1 mi. ESE (MVZ 1/1); Jawbone Station (MVZ 7/7), 1.8 mi. NNW by road (MVZ 1/1), 2.4 mi. NW by road (MVZ 1/1); Jawbone Ridge, 3.5 mi. in an air line SSW (MVZ 8/8) and 8.2 mi. by road SSW (MVZ 1/1) Jawbone Station.

Records of unspotted Ensatina *in the Sierra Nevada.*—There are several records in the literature of the coastal unspotted *Ensatina* (prior to the present study known as the race *eschscholtzii*) in the Sierra Nevada (Slevin, 1928; Storer, 1925; and Bishop, 1943). The author has examined the specimens upon which these records are based. All prove to be *platensis* except one from Fresno, California, that may bear inaccurate locality data, and a juvenile from Bear Valley, Mariposa County, California, the identity of which is uncertain. The localities are listed below with annotations. In each instance, error in identification stems from obscurity of the characteristic dorsal spotting. The specimen labelled "Fresno" is presumed by some authors, possibly correctly, to have come from the Sierran foothills. There are at this writing no unquestioned records of *Ensatina* in the Great Valley and under present conditions it appears unlikely, apart from the region opposite San Francisco Bay, that they could maintain self-perpetuating colonies there. It is, of course, possible that occasional individuals are carried out into the valley from the surrounding hills by high water following storms. Such a waif may account for the Fresno record. Another possibility lies in transport by human agency, in leaf mold.

CAS 33387, ad. ♂, b. 64 mm., collected by Van Dyke, Strawberry Valley, El Dorado Co., Calif., Aug. 11, 1912. The specimen has been reported by Storer (1925) and Slevin (1928). Both authors list it as *Ensatina eschscholtzii*.

Through the courtesy of Mr. Slevin, I have had an opportunity to study this animal. It proved to be *platensis*. Misidentification had probably resulted from obscurity of the characteristic spots due to preservation in excessively strong

alcohol. When examined under a dissecting microscope, breaks in the melanic ground color could be seen which fitted the pattern of *platensis*. Such light patches appeared behind the eyes, on the body (although few and relatively small), on the upper surface of the tail, and on the outer surface of the distal segments of the limbs; the ventral surfaces were covered with a uniform melanic stippling characteristic of *platensis*.

USNM 104555, ad. ♂, b. 54 mm., collected by G. Eisen, Fresno, California. Discolored and shrunken by strong alcohol. This specimen would seem to be either *platensis* that completely lacks dorsal spotting and has much reduced or no melanophores in the walls of the body cavity or a specimen of *oregonensis*. The minute rather evenly and widely spaced ventral melanic stippling in conjunction with an unspotted dorsum is characteristic of *oregonensis*. Eisen is known to have collected earthworms north of San Francisco Bay and may have obtained the salamander on such a trip. However, occasional individuals of *platensis* have much reduced spotting although I have never seen one which lacked spots completely. Usually some can be found, often on the tail when nowhere else. Unfortunately, the tail of this specimen is missing. The mountains east of Fresno are occupied by *platensis* that exhibit a trend toward large spots; in southern Sequoia Park, somewhat farther south, the beginning of intergradation with *croceator* apparently takes place. Nevertheless, although many individuals are notable by their large and numerous spots, occasional animals have much reduced spotting. In fact, at the same locality, Heather Lake Trail, Sequoia National Park, two individuals were collected, one almost unspotted and the other with many large spots (LAM specimens).

There is also the possibility that Eisen's specimen came from the coastal mountains in the vicinity of Fresno. The absence of pleuroperitoneal stippling is in keeping with this view but uniform ventral stippling in *Ensatina* is not known to occur coastally south of San Francisco Bay. I think that the specimen is an unspotted or obscurely spotted individual of the race *platensis*.

Storer (1929) thinks that some at least of Eisen's "Fresno" material was collected in the adjacent hills, miles distant and in a different zonal and faunal area.

SCB specimen, b. 29.5 mm., collected by B. H. Dunbar, Bear Valley, 50 ft., Mariposa Co., Calif., March 7, 1926. This individual is almost wholly without light marks. However, the distal half of the tail has a narrow longitudinal light-colored dorsal band. On the right side this band unites with two small blotches which lie just posterior to the middle of the tail. There are a few minute light flecks basally on the sides of the tail and along the sides of the body between the limbs. Under magnification the upper eyelids appear faintly mottled with light color. The ventral surfaces are flecked with melanophores along the lower sides and laterally on the abdomen. A band, about ⅓ the width of the abdomen along the midline, is largely unmarked as is the undersurface of the tail, proximal segments of the limbs, and pelvic region. There are a few flecks about the cloaca and on the chest. Melanophores are sparse in the central gular area but become denser along the margin of the jaw.

The identity of this individual cannot be determined with certainty but its generally light pigmentation and weak ventral melanophore development, in conjunction with the known occurrence of *xanthoptica* on Jawbone Ridge some 18 miles away, strongly suggest that it is of this race.

The elevation given for the site of collection must be in error. According to the USGS map (1897), Sonora Quadrangle, the elevation of the town of Bear Valley is 2,100 ft. and nearby Bear Creek, shown as an intermittent stream, drains into the San Joaquin Valley. The San Joaquin River which receives the drainage from the Sierran foothills lies about 45 miles due west from Bear Valley at an elevation of 50 feet.

NOMENCLATURE

In 1875 Jiménez de la Espada described *Urotropis* (=*Ensatina*) *platensis*. The description was based upon a single specimen, presumably from the vicinity of Montevideo, Uruguay. Concerning the specimen Espada writes (as quoted by Dunn, 1926:184–185):

"I regret extremely that it is not possible for me to determine exactly the locality where it was caught. I received it from my travelling companion Sr. Martinez y Saez, along with various reptiles from the neighborhood of Montevideo or from its Province, and noticed it in Chile when we were arranging and annotating our third shipment to Spain. I remember very well that I remarked upon the find to the Director of the Museum of Santiago, my good friend Dr. Rodulfo Armando Philippi, who took it for an interesting novelty. When I wished to verify this opinion, long afterwards, my companion was doubtful as to the person from whom he received the urodele, whether it was Sr. D. Fernando Amor or the Ex. Sr. D. Patricio Maria Paz y Membiela; and these gentlemen died, one during the trip, the other more than a year ago. But my carelessness has no other consequence than the lack of local data in the account of the new batrachian, a lack always noticeable, but it does not detract from the importance of the discovery, which consists in the region that it inhabits, not in the district, place, or spot where it lived." It is seen from Espada's account that the collection site of *platensis* is unknown, although he believes the salamander came from Montevideo or its environs.

Dunn (1926) gives an almost complete translation of the original description of *Ensatina* (=*Urotropis*) *platensis* and reproduces the original excellent illustration that accompanied it. In comparing *platensis* with spotted *Ensatina* of the Sierra Nevada of California, he directed attention to the close similarity between the two. The only difference indicated by Dunn was in the costal groove count, there being 10 or 11 in *platensis* and 12 in *croceator*[12] (the name then used to designate the Sierran *Ensatina*). In view of the difficulty in counting costal grooves and Espada's uncertainty as to their number,[13] this

[12] This name was applied to all spotted *Ensatina* until Storer (1925) separated *sierrae*, the Sierra Nevada salamander, from *croceator*, the blotched form in the mountains of southern California, the type locality of which is Fort Tejon, Kern County. In the present paper the name *croceator* has been further restricted.

[13] Through the courtesy of Dr. Ernesto Cusi, I have recently obtained a photograph of the type and I count 12 costal grooves (pl. 14).

difference probably is not significant. Furthermore, as Myers and Carvalho (1945) point out, and my own studies support, *sierrae* may occasionally have this number.

Myers and Carvalho (1945) give sound reasons for their belief that *platensis* and *sierrae* are specifically identical but a direct comparison with the type of *platensis* was not made. The close similarity between the two, the lack of other specimens of *platensis*[14] and the uncertainty of the collection locality are basic to their view.

The location of the type specimen of *platensis*, until now, had not been generally known with certainty. It was thought to be in the Madrid Museum (Dunn, 1926). In February, 1946, I received word in response to an inquiry regarding the type that it was in the Instituto José de Acosta, Museo Nacional de Ciencias Naturales, Madrid, Spain.

A direct comparison has been made between the type of *platensis* and specimens of *sierrae* by Dr. Ernesto Cusi, Curator of Herpetology at the National Museum of Natural History, Madrid, Spain. He believes that they are "probably" the same species. From photographs (pl. 14) and specific data requested regarding the type, the author finds it identical with *sierrae* in all characters compared.

The question arises how a rather uncommon salamander from the Sierra Nevada of California might have appeared in a Uruguayan herpetological collection. Myers and Carvalho (1945: 4–5) provide an answer: ". . . if one considers the history of this part of California [Sierra Nevada], such an occurrence becomes less remarkable than it appears at first. Espada's original description of *Urotropis platensis* was published in 1875, only 25 years after the discovery of gold in California and the beginning of the great 'gold rush' which brought people from all over the world to search for fortune in the mountains of California. The gold region of California is the habitat of *Ensatina sierrae*. Is it unreasonable to presume that some Uruguayan, working among the thousands of miners who crowded these mountain valleys from 1850 to 1870, found a specimen of this salamander, preserved it in a bottle of whiskey, and brought it back to Uruguay with him?"

With the location of the type specimen of *platensis* and its recognition as a specimen of the Sierra Nevada *Ensatina*, the use of the name *sierrae* is no longer tenable. In conformity with the Rule of Priority, the Sierran form must be known as *platensis*, a ridiculously inept name for an endemic Californian salamander.

Prior to the present study, in the absence of intergrades between the Sierran and the coastal forms of *Ensatina*, the former was considered a full species. It is now necessary to reduce *sierrae* (=*platensis*) to subspecific status under *eschscholtzii* in view of the presence of an intergrading population between the animals of the northern Sierra and those of the Coast Range in northern California.

[14] Berg (1897) reports 2 specimens taken in a ditch near the Ensenada, province of Buenos Aires, in 1887. Myers and Carvalho (1945) doubt that they were *Ensatina*. The reader is referred to their paper for details.

HYBRIDIZATION BETWEEN **xanthoptica** AND **platensis**

A population of *xanthoptica* occurs on Jawbone Ridge, 4.5 miles south-southwest of Jawbone Station, 3,100 feet, Tuolumne County, California, within the range of *platensis*. On April 18, 1948, a group from the Museum of Vertebrate Zoölogy found an adult female and 3 juveniles within about ¼ mile of a site where a number of *platensis* were procured. The author was in the Jawbone area from April 30 to May 1, 1948, and with the assistance of Mr. and Mrs. Thane Riney, collected 15 *platensis* and 10 *xanthoptica*. All the *xanthoptica* came from an area approximately 200 feet in diameter, at the place where this race was obtained earlier. No *platensis* were taken within this zone although one was found several hundred feet away. Of particular interest was the discovery of an individual which presumably was the result of a successful mating between members of these markedly different races. This strikingly marked animal was found in the area occupied by *xanthoptica*.

The *xanthoptica* colony was situated along a contact between Transition and Upper Sonoran vegetation. Upper Sonoran growth, consisting of chamise (*Adenostoma fasciculatum*) and Digger pine (*Pinus sabiniana*), extends well into the gradual western slope of the Sierra Nevada along the many east-west drainages that reach the Great Valley of California. The Tuolumne drainage is one of these systems. But tongues of Transition vegetation, consisting of yellow pine (*Pinus ponderosa*), incense cedar (*Libocedrus decurrens*), and black oak (*Quercus kelloggii*) project valleyward along the ridges, as on Jawbone. It is believed that *xanthoptica* may occur primarily in the Upper Sonoran Zone of the Sierra opposite the Bay, as it does coastally, ranging into Transition, as it also does in the east-Bay area. *Platensis* seems to be primarily a Transition animal but it is known to extend into Upper Sonoran areas. Thus the habitat tolerances of these races is such that overlap of their ranges can and does occur. That their tolerances overlap even more specifically, approaching the level of the niche, is indicated by the hybrid animal.

Study of the pigmentation of *xanthoptica* from the Sierra reveals that they are closely similar to east-Bay representatives of this race. They seem to differ slightly, however, in having somewhat weaker dorsal melanophore development. They appear somewhat lighter colored and the darker dorsal coloration does not seem to extend as far down on the sides of the body as it does in animals from the east-Bay. Melanophores of the ventral surfaces, however, seem to be slightly more abundant and less often clumped to form discrete blotches. Additional specimens will be required to define the characteristics of this Sierran population. On the basis of the material available it appears that weak color differentiation exists.

The hybrid individual, an adult female, RCS 2357, is figured (plate 12, figs. 27 and 29). It is marked essentially like *platensis* except for an extensive suffusion of orange pigment over all dorsal surfaces and on the distal segments of the limbs. The ventral surfaces are marked with orange blotches, so far not observed in *platensis*.

It is believed that *xanthoptica* is of comparatively recent occurrence in the

Sierra and that the race there is at the present time rather narrowly limited in distribution. The morphological distinctness of the coastal and interior races and their ability to maintain this distinctness in the face of their present junction, suggest that they previously had been geographically isolated for a considerable period. This period was of sufficient duration to permit genetical divergence to a point where fertility or the inclination or opportunity to mate (through changes in habits) was markedly reduced. At some time following this separation the barrier must have been removed and the coastal type, probably less limited in zonal tolerance (as it appears to be today), was able to disperse across the Great Valley, presumably principally along stream courses, to the Sierran foothills.

Whether *xanthoptica* exists at the present time on the floor of the Valley opposite the Bay is unknown. Much collecting in this area has failed to reveal it. Yet that there was at some time in the past, following disappearance of the saline conditions of the inland sea that once occupied this region, an avenue of dispersal suitable for *Ensatina* is suggested by the present-day Oakdale flora, perhaps a remnant of more widespread vegetation of this type. At this locality (Oakdale) between the Bay and the Sierran foothills, is an area of oak woodland with interior live oak (*Quercus wislizenii*), blue oak (*Quercus douglasii*), and elderberry (*Sambucus*), vegetation in association with which *xanthoptica* might be expected to occur. This flora represents an extension of Upper Sonoran vegetation characteristic of the Sierran foothills out onto the flood plain of the Valley where it is to a considerable extent surrounded by Lower Sonoran conditions. Axelrod (see Chaney, *et al.*, 1944:160) reports on a fossil flora from this area considered to be of middle Pliocene age that suggests a climate differing from present conditions in the region in having a higher rainfall, summer as well as winter precipitation, and occasional moderating fogs and ocean breezes resulting in cooler summers. During such a cooler, wetter period, dispersal of *xanthoptica* across the valley may have occurred, if indeed it is not now present there.

To what extent *xanthoptica* has succeeded in exploiting its newly found area of activity is unknown. There is a sight record that I believe reliable for the race at the Berkeley Tuolumne Camp, Tuolumne County, about 7 miles in an air line east-southeast of Jawbone Station. A juvenal specimen—loaned by Dr. Sherman C. Bishop—that was obtained at Bear Valley, Mariposa County, California, may be of this subspecies. Owing to the relatively uniform conditions available through slight changes in altitude by animal populations along the north-south axis of the Sierra, it would seem that, if not now widely distributed, the distributional potential for the race is the entire western foot of the Sierra. What effect this invasion will have on the more zonally restricted *platensis* is a matter for speculation.

INTERGRADES BETWEEN **oregonensis** AND **platensis**

Oregonensis intergrades with *platensis* in the mountains that connect the northern Sierra Nevada and the southern Cascades with the Coast Range. Trends in characters in the zone of intergradation traced from the coast in-

teriorly may be summarized: (1) The uniformly brown dorsal surfaces of *oregonensis* gradually become disrupted by small orange flecks that increase in size and unite in various ways to form blotches, finally culminating in the orange spotting characteristic of *platensis.* (2) Melanism of the proximal segments of the limbs becomes reduced, intergrades having uniformly light-colored segments like *platensis.* (3) The lipophore network of the ventral surfaces becomes disrupted, passing through stages of blotching and spotting to complete loss. (4) Guanism of the skin is reduced. (5) The iris patch shows marked decline in size but becomes more conspicuous again in *platensis.*

ANALYSIS OF COLORATION: SPOTTING

Adults are variously mottled and spotted with orange on the dorsal and lateral surfaces of the head, body, tail, and distal segments of the limbs. The markings range in size from minute pin points of color to blotches 5 or 6 mm. in greatest linear dimension, as at the tip of the tail of one individual. Body blotches, however, are usually less than 2 mm. All marks have diffuse outlines and many have a scattering of melanophores through them. The spots differ from those of typical *platensis* in vagueness of outline, clouding, greater variability in size, and a tendency toward irregular distribution and coalesence resulting in a general mottled effect. Some individuals show a tendency, found in *platensis,* toward clustering of markings on and about the eyelids. The tail and distal segments of the limbs are heavily mottled and blotched, usually more so than the body. The head, except for the eyelids, shows less spotting.

Juveniles have no dorsal spotting. All individuals (13) below 40 mm. in snout–vent length are unmarked. An individual 48 mm. long has minute spots on the body, the largest of which is .3 mm. in diameter. Animals above this size tend to have larger blotches with increasing size.

There is a degree of similarity in the dorsal mottlings to the markings in *picta,* and the markings of the regenerated tails of two individuals closely resemble those of the tail of *picta* although original markings ordinarily do not (text fig. 16, p. 500).

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Coloration of the proximal segments of the limbs is intermediate between *oregonensis* and *platensis.* In the absence of differences in this character correlated with age and sex and also the lack of a geographic gradient within the intergrading zone, all individuals (10j., 7s., 7 ad.) have been grouped. Thirteen have the proximal segments entirely[15] light colored, 3 are intermediate between completely and ⅔ light colored, 5 are ⅔ light colored and 7 are between ⅔ and ⅓ light colored. The hind limbs usually show somewhat less reduction in melanophores than the fore limbs. The dark color of the proximal segments is sometimes mottled. Preceding estimates are based on the average condition, taking both fore and hind limbs into account.

[15] In several instances there were a few melanophores inside the elbow or knee, but these scattered cells were disregarded.

The race *platensis* typically has completely light-colored proximal segments and *oregonensis* ½ to ⅔ light-colored proximal segments.

Ventral surfaces.—Of twenty-nine animals, 11 are medium, 9 between medium and great, and 8 are great in development of ventral melanophores. Fifteen of those classed above as greater than medium for this character are subadults (5) and juveniles (10). Only one subadult is considered as less than medium in ventral stippling.

There is no significant change in melanophore development in the intergrading zone.

Pleuroperitoneum.—Melanic stippling of the pleuroperitoneum is present as shown by fifteen individuals of varying size, selected at random. Such stippling appears to be quite uniform and conforms closely, as to number of cells, with that of the ventral surface of the body.

LIPOPHORES

The lipophore network, present in most adult *oregonensis* (from California) as a uniform or moderately broken reticulum, gives way to scattered blotches and spots in the zone of intergradation. In this area, ventral lipophores may or may not be present in adults while juveniles do not appear to have them. When found, they usually form small clusters which spot the ventral surfaces with pale orange. Spotted individuals are found as far inland as the mountains north of Redding but the few available from Burney, farther east, near the zone of juncture with typical *platensis,* lack ventral lipophores. *Platensis* is characteristically without liphophores ventrally except on the undersides of the limbs.

The lipophore coloration of the proximal segments of the limbs is lemon yellow in juveniles and changes with growth through yellowish orange to orange in adults.

GUANOPHORES

Skin.—Like *oregonensis* in northern California, animals from the intergrading zone, in general, show heavy guanism. Juveniles have a sprinkling of these cells over all dorsal surfaces except for the proximal segments of the limbs; they are not commonly present ventrally. In young animals, gaps may appear in dorsolateral areas corresponding to zones of dark blotching in the race *picta.* The cells are pale blue, white, or silvery.

Adults likewise are heavily marked. Guanophores may be so abundant dorsally as to impart a hoary suffusion to the skin. Many animals have them concentrated in greatest numbers on the head and upper eyelids and dorsally in the pelvic area and at the base of the tail. Occasionally a few are found ventrally, often in the gular area. *Oregonensis* seems to show less tendency toward this type of differential distribution but rather is more inclined toward concentration along the sides.

An irregular deeply situated patch of guanophores is present at the upper base of the limbs, beneath the lipophore network.

Iris.—There is rapid reduction in frequency of occurrence and size of the eye patch as one proceeds inland from the area occupied by *oregonensis* (text

fig. 12, p. 481). In the mountains north of the Sacramento Valley, this decline reaches its peak with nearly 50 per cent of the population lacking iridic guanophores and the remainder having only one to four cells in the upper iris (as based on 29 animals from scattered localities). Guanism of the iris becomes more extensive again in the race *platensis*. Iris guanophores are silvery to golden in color.

COLORATION IN LIFE

Marked changes in coloration accompany growth: young-of-the-year, solid black above on head, body, and tail, grading to sooty ventrally; distal segments of limbs black, becoming somewhat lighter on feet and toes; proximal segments of limbs yellow above, pinkish ventrally; numerous pale blue and silvery guanophores scattered over dorsal and lateral surfaces except for proximal segments of limbs; guanophores fewer on distal segments; iris dark brown, sometimes with several silvery or bronze guanophores in upper part.

With growth, dorsal and ventral ground color lightens; proximal segments of limbs develop an orange cast; guanophores become somewhat less apparent; minute, pale orange flecks begin to appear on all dark-colored dorsal surfaces. As full size is reached, dorsal ground color becomes dark brown instead of black, and diffuse and irregular spotting of light orange becomes established; ventral surfaces become gray or whitish and orange blotches may appear; proximal segments of limbs become pale orange; guanophores are still apparent on all dorsal surfaces except proximal segments of limbs; they are most abundant on eyelids, lower back between hind limbs, at base of tail, and along sides of head and body; they are few in number on distal segments of limbs.

HABITAT

From November 12 through 15, 1945, the author collected *oregonensis-platensis* intergrades in the mountains surrounding the north end of the Sacramento Valley, California. Exploration was conducted using the town of Redding as a base and driving out into the hills, first east on U. S. Highway 299 toward Burney, then north on U. S. Highway 99 toward McCloud and finally west on U. S. Highway 299 toward Eureka.

Animals were procured in the following places: under rocks (7), boards (6), logs (9) (2 inside), bark (3), decayed wood (2). Most individuals were found where there was considerable leaf litter, although several were taken under rocks on bare soil where there was little herbaceous cover.

Vegetation at most localities consisted of yellow pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), black oak (*Quercus kelloggii*), and incense cedar (*Librocedrus decurrens*)—trees of the Transition Life-zone. But individuals were taken also in areas with manzanita (*Arctostaphylos* sp.), Digger pine (*Pinus sabiniana*), canyon live oak (*Quercus chrysolepis*), toyon (*Photinia arbutifolia*), and blue oak (*Quercus douglasii*) in the high Upper Sonoran Zone. Individuals were found in the hills 7 miles west of Redding but none was obtained on the floor of the Sacramento Valley.

DISTRIBUTION

Intergrades are known from near Burney, west, through the mountains north of the Sacramento Valley, to Harrison Gulch and south to White Rock Ranger Station in Trinity County, in the interior coastal mountains bordering the west side of the Sacramento Valley. Animals from two localities in Jackson County, southern Oregon, near the California line, are also considered as intermediates, although they are included with uncertainty because living individuals have not been seen.

Locality records.—OREGON: *Jackson Co.*—Near head of Poorman's Creek, 2 mi. S Jacksonville, 2,700 ft. (MVZ 1/1);[16] 2.2 mi. S Siskiyou, 100 yds. SW air beacon no. 30, E of U. S. Highway 99 (SNHM 1).[17] CALIFORNIA: *Shasta Co.*—Willow Creek (MVZ 1); 12.5 mi. NW Shasta, along U. S. 299 (MVZ 1/1); Sweet Briar (CAS 1); Hazel Creek, 1,650 ft. (MVZ 4/4); 100 ft. S U. S. 299, 14.5 mi. W (MVZ 2/2), and 50 ft. S U. S. 299, 24.6 mi. W Burney (MVZ 1/1); 23.5 mi. N junction U. S. 299 and 99, on U. S. 99 N Redding (MVZ 8/8), 27.4 mi. N (MVZ 1/1), and 35.9 mi. N (MVZ 1/1); 7.6 mi. W Redding on U. S. 299 (MVZ 3/3); McCloud River (CAS 1); Harrison Gulch, 2,600 ft. (MVZ 3/3). *Siskiyou Co.*—Shasta Retreat (Slevin, 1928);[18] vicinity McCloud (SNHM 1); Mount Shasta, Mud Creek, 6,700 ft. (Dunn, 1926).[19] *Trinity Co.*—20.5 mi. E Weaverville, on U. S. 299, 3,300 ft. (MVZ 1/1), 19.3 mi. E on NE side U. S. 299 (MVZ 4/4), and 3.4 mi. E on U. S. 299 (MVZ 1/1); White Rock Ranger Station, 4,800 ft. (MVZ 8/8).

INTERGRADES BETWEEN **platensis** AND **croceator**

The following analysis is based on 15 individuals that are intermediate in color and pattern. They come from the Kern River drainage, at the juncture of the Sierra Nevada and the Tehachapi Mountains—ranges occupied respectively by *platensis* and *croceator*. The beginning of the trend toward *croceator* appears as far north as Sequoia National Park but in the absence of specific locality data for animals from there, they have not been included in this analysis. They are discussed in the section on *platensis*.

The intergrading character of the population of the Kern River area is shown by the following: (1) The dorsal spots are intermediate in size and color. (2) There is a tendency toward blotch formation in the parotoid areas, suggestive of the markings of *croceator*. (3) There is a tendency toward loss and reduction of spots on the eyelids, *croceator* usually lacking eyelid markings. (4) The distal segments of the limbs often are uniformly colored. (5) There is reduction in guanism of the skin, approaching that of *croceator*.

ANALYSIS OF COLORATION: SPOTTING

(Plate 12, fig. 17)

The dorsal markings are highly variable but a few generalizations may be made: (1) All but one individual possesses spots approaching in size those of *croceator* and larger than those of typical *platensis* (pl. 13, fig. 5). The spots have irregular borders and are variously shaped—rounded, oval, lobed, and sometimes rectilinear (pl. 13, fig. 6), the latter suggestive of the race

[16] Of uncertain affinity.
[17] Very obscure mottling.
[18] Listed by Slevin (1928) as *E. croceator*.
[19] Listed by Dunn (1926) as *eschscholtzii*.

klauberi. (2) The spots tend to be arranged in two longitudinal rows on the body, rarely occurring in the midline except on the tail and behind the hind limbs on the body. This corresponds to the arrangement in *croceator; platensis* to a lesser degree also may show this tendency. (3) The blotches may be large enough to give the tail a somewhat banded appearance. Such banding reaches its fullest development in the race *klauberi.* (4) Spotting of the upper eyelids, so universally present in *platensis,* declines as *croceator* is approached. Of 10 animals, from north of the Kern River Valley, two show reduction in spotting, each having one eyelid unmarked and the other weakly spotted. These animals come from California Hot Springs and Quaking Aspen Meadow, Tulare County. South of the Valley, near Piute Peak, 5 individuals were obtained, one with uniformly dark-colored eyelids like typical *croceator,* two with much reduced spotting, and the others with typical *platensis* markings. (5) There is a tendency toward clustering of spots to form irregular blotches in the parotoid regions (pl. 13, fig. 9). In *croceator* (pl. 13, fig. 11) a single large blotch is present in each parotoid area whereas head spots are of irregular distribution and of varying size and abundance in *platensis* (pl. 13, fig. 4).

All individuals classed as intergrades, with the exception of two animals from California Hot Springs, Tulare County, have spots on the head clustered to form an irregular blotch in each parotoid area. These blotches remain separate at the midline except in one individual. They may or may not be connected to the eyelid spots.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Limbs.—Light color extends to the elbow and knee in most individuals. One, from Quaking Aspen Meadow, has melanophores extending on the proximal segments of the hind limbs to about ¼ the distance between the knee and limb base but on the fore limbs melanism stops at the elbows. An individual from White River and one from California Hot Springs, Tulare County, have light color extending slightly beyond the knee and elbow. *Croceator* and *platensis* typically have completely light-colored proximal segments.

The distal segments are largely uniformly colored, somewhat lighter than the dorsal ground color of the body but occasional individuals may have a spot or two on the limbs. The race *platensis* often shows considerable spotting whereas in *croceator* spots are usually absent.

Ventral surfaces and pleuroperitoneum.—The distribution of melanophores on the venter and in the body cavity resembles that of *platensis.*

LIPOPHORES

The color of the dorsal spots is largely determined by the color of the pigment of the lipophores. Typical *platensis* has orange or reddish orange markings while those of *croceator* are lemon yellow or yellowish cream. Intergrades are intermediate in color, often having yellowish orange markings. Young tend more toward yellow than adults do. As with *platensis* and *croceator,* lipophores are absent ventrally except occasionally on the proximal segments of the limbs.

GUANOPHORES

Skin.—Living individuals have been observed from Kern County Park (4) and near Piute Peak (5). On the basis of these animals, it appears that there is intermediacy in guanophore development. Juveniles have a sprinkling of these cells on the head, including the upper eyelids, with the number of cells diminishing posteriorly. A juvenile (35 mm.) from near Piute Peak has them confined to the head and neck and dorsal surfaces of the distal segments of the limbs, about as in subadult *croceator*. Adults (3) possess no discernible guanophores in the skin, except for the deep guanistic network at the base of the limbs, largely characteristic of the species as a whole. Superficial skin guanophores are pale blue or whitish in color.

Iris.—Intergrades resemble *platensis* in iris pigmentation. The color of iridic guanophores ranges from silver to copper, the latter being more common.

COLORATION IN LIFE

The colors of two individuals have been checked with Ridgway.

Adult ♂, Mus. Vert. Zoöl. no. 41792, b. 67.6 mm., Kern County Park, 11 mi. NW Kernville, Kern Co., Calif., collected by author December 11, 1945 (pl. 12, fig. 17). Dorsal ground color Carob Brown; spots on body and tail Capucine Yellow, those on eyelids Buff Yellow; proximal segments of limbs above Salmon Color except for central longitudinal strip of Capucine Buff; distal segments of limbs Light Drab, unspotted; ventral surfaces white, with a few scattered melanophores; left iris uniformly dark brown, right with a single Pale Viridine Yellow guanophore above pupil.

Juvenile, Mus. Vert. Zoöl. no. 41793, b. 26 mm., from same locality as no. 41792 (pl. 12, fig. 22). Dorsal ground color solid black; spots on body and tail Light Orange Yellow; proximal segments of limbs above Baryta Yellow; distal segments black, lightening on feet; toes with dark and light crossbands due to lightening at joints; generally dusky below but Pallid Neutral Gray in lighter areas; iris with faint trace of silvery with greenish tinge in upper part of both eyes; guanophores pale purplish blue in color, numerous on upper surface of head (including eyelids), few on body, sides, and distal segments of limbs.

HABITAT

Kern County Park, 11 mi. NW Kernville, Kern Co., Calif., December 11, 1945. An adult male and 3 young were found beneath a slab of wood $2\frac{1}{2}' \times 1' \times 3''$, one of a number lying down slope at the base of a sawed Douglas fir stump. The soil was black, rich in humus, and damp. The site of collection was in a shallow depression with a 10° slope to the north. Fifty yards below, water from this seepage area trickled down a shallow gully into an east-west canyon.

The area was well shaded by incense cedar, yellow pine, and black oak. There was little understory vegetation. A heavy leaf mat was present. Many uprooted, sawed stumps lay about. Under most of them the soil was dry.

Two to three inches of fresh snow covered the ground, except beneath trees where drippage from melting snow in the branches had melted that on the

ground. The animals were found in such a snow-free area. The weather was unsettled, with occasional light snowfall and intermittent sunshine. The animals were found about 1:00 p.m.

DISTRIBUTION

The change from typical *platensis* to *croceator* occurs in the area of the Kern River drainage. Intergrades are known from both sides of the Kern River Valley, north at least to Quaking Aspen Meadow, southern Tulare County, and south into the Piute Mountains of northern Kern County (pl. 15, fig. 2).

Zonally intergrades range from the Upper Sonoran to the lower Boreal Life-zone. Locality records for individuals which, on the basis of several characters, have been considered as intergrades follow.

Locality records.—CALIFORNIA: *Kern Co.*—Kern County Park, 11 mi. NW Kernville (MVZ 2/4); 1 mi. W and 3½ mi. N Piute Peak, near Saddle Springs Camp, 7,500 ft. (MVZ 5/5). *Tulare Co.*—Quaking Aspen Meadow, 7,500 ft. (MVZ 3); California Hot Springs (CAS 2); White River (SNHM 1).

Ensatina eschscholtzii croceator (Cope)

Plethodon croceator Cope, 1867:210, original description, part.
Ensatina croceator, Dunn, 1923*a*:39, part.

Type.—Adult male (?), no. 4701, U. S. National Museum (now lost); collected by John Xantus at Fort Tejon, Kern County, California.

The type locality has long been questioned. Until recently, aside from the type, no *Ensatina* were known from the Fort or the surrounding mountains. In 1930 Joseph Slevin reported a specimen collected by E. C. Van Dyke under some boards near the Fort. In December, 1945, I found two spotted individuals in a canyon about a mile southwest of the Fort. Since then other specimens have been taken and at the present time 15 individuals are known from the area. Cope's description of the animal collected by Xantus fits those now known to occur there, at least as to pattern. I quote from Cope (1867: 210): "Color throughout pitchy black, fading into bright red orange below; limbs orange, a blackish cross band below the knee. A large red orange spot on each parotoid region, and four smaller irregular similar spots on the body to the base of the tail, on each side of and near the vertebral line. A pair of orange spots at the base of the tail, and a distant series on the upper face of the tail."

The parotoid spots and the character of the spotting of the body is unmistakably that of *croceator* as recognized in this paper. Although no animal taken to date has had red-orange in the coloration, this color may have resulted from changes due to preservation.

Measurements of the type, given by Cope, indicate that it must have been an adult male. Only in males does the tail exceed the snout-vent measurement.

Description.—Adult with dorsal pattern of irregularly outlined, lemon-yellow to yellowish cream spots of variable size and shape; spots generally larger than in *platensis* and smaller than in *klauberi*, ranging from less than 1 mm. to 7 mm. in greatest linear dimension, averaging 3 or 4 mm. in width; large spot regularly present in each parotoid region; parotoid spots broadly

separated at midline; upper eyelids commonly without pattern; ground color above solid black to deep blackish brown, blending laterally with pale gray of venter; ventral surfaces with stippling of melanophores; proximal segments of limbs yellow above, lighter below; distal segments of limbs usually unspotted, slightly lighter than ground color of upper surface of body; toe joints lighter than remainder of foot, giving toes faintly crossbanded appearance; iris dark brown, sometimes with several silvery to bronze guanophores (3 to 10 in animals studied) in upper part and none or 1 or 2 in lower part; guanophores may appear in small numbers on upper surface of head and sometimes elsewhere, as on tail.

Color changes with growth.—On the basis of 13 individuals of varying size from juvenile to adult, the following changes appear to occur: juvenile with uniformly black ground color above, broken by blotches of bright lemon yellow; proximal segments of limbs above similar in color to dorsal blotches; distal segments of limbs somewhat lighter than ground color of body; ventral surfaces gray, except for under side of proximal segments of limbs which may be pale yellow; dorsal and ventral colors grade gradually along sides of head, body, and tail; guanophores concentrated on upper eyelids, interorbital region, and snout, but also sometimes present elsewhere as on upper surface of tail. With growth, dorsal and ventral ground color lightens and in old adults may become deep blackish brown and pale gray, respectively; yellow color in pattern lightens and in old individuals becomes cream colored; guanophores of skin may disappear entirely or become largely confined to head.

Diagnosis.—Distinguished from coastal *Ensatina* by presence of dorsal light-colored spots on head, body, and tail and from other spotted races of California as follows: Differs from *platensis* in having single large blotch in each parotoid region, essentially uniformly colored distal segments of limbs, and darker dorsal ground color. Differs from *klauberi* in having smaller and more irregularly outlined dorsal blotches, that are seldom of rectilinear form; in lacking diagonal or crossbands on body; in regularly having unconnected parotoid spots that rarely extend onto upper eyelids, and in usual absence of an extension of parotoid markings on sides of head below postorbital furrow; parotoid spots separated by distance equal to half or more width of spot whereas when unconnected in *klauberi,* they are usually much less widely separated.

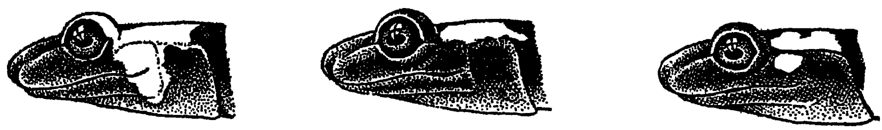
In life, further differs from *platensis* and *klauberi* in color of dorsal blotches. Both young and adults of these races have orange markings, except for occasional large individuals of *klauberi* that have pale orange to cream-colored blotches. All fully grown *croceator* known (5) have cream-colored or pale lemon-yellow markings whereas blotches of juveniles and subadults are yellow. Upon preservation, diagnostic yellow color is usually lost.

ANALYSIS OF COLORATION: SPOTTING

Body and tail.—Dorsal markings are generally intermediate in shape and size between *platensis* and *klauberi* (pl. 12, fig. 18) although considerable variability is present. In a single individual one may find marks with irregu-

lar outlines and others with rather smooth contours, the former characteristic of *platensis,* the latter *klauberi.* Likewise, in size the spots of an individual may range from marks similar to those of *platensis* to those of *klauberi.* As with these races, blotches tend to be arranged in series on either side of the midline. The general form and arrangement of the spots favors *platensis.* The cream color of the markings contrasts with the more generally orange coloration of the other races.

Parotoid areas.—Blotching of the head is much closer to *klauberi* than *platensis.* In all individuals examined, a single large rectilinear, although often irregularly outlined, blotch occurs in each parotoid area. These blotches are not united in the midline (as based on present material) as is true in slightly over 50 per cent of specimens of *klauberi.* Typical *platensis* has much



1 2 3

Fig. 9. Variation in lateral aspect in the form of the parotoid blotch. (1) *klauberi;* (2) *croceator;* (3) an intermediate condition of occasional occurrence in *croceator.*

smaller, more numerous, scattered blotches on the head, lacking symmetry of arrangement.

The blotches do not extend onto the upper eyelids, except in one adult female, that has two light spots on the right upper lid and another that has a slight encroachment of the parotoid mark onto the left eyelid. In this respect the race differs from *platensis* which almost invariably has light-colored marks on the upper lids and from *klauberi* which typically has such marks connected with the parotoid markings.

No individual possesses extensions of the parotoid markings on the sides of the head to the gular area as are present in *klauberi* but 3 animals have a small amount of light color below the postorbital furrow (text fig. 9).

Limbs.—As with *platensis, croceator* has uniformly light-colored proximal segments of the limbs. The light color meets the distal dark coloration at the elbow and knee. The distal limb color, which is somewhat lighter than the dorsal ground, is unspotted in 7 individuals. Four animals, however, have several light spots on the fore limbs near the elbows, and 3 have a single light spot on one or another of the limbs. The toe joints are lighter colored than the remainder of the toes, giving the toes a faintly crossbanded appearance.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Ventral surfaces.—Ten animals are medium (5♀), or slightly above (1j, 2s, and 2♂) in development of ventral melanophores. The small individuals possess more prominent stippling than the adults. The race is like *platensis* in the number and distribution of these cells.

Pleuroperitoneum.—Seven individuals, all from Fort Tejon, possess melanophores in the lining of the body cavity. Presumably, as in *platensis,* these cells are uniformly present.

LIPOPHORES

There are no ventral lipophores. Those responsible for the color of the dorsal light-colored markings impart a lemon-yellow to cream-colored hue, depending upon the age of the individual.

GUANOPHORES

Skin.—*Croceator* has fewer skin guanophores than *platensis.* Adults may lack them completely or may have only a light sprinkling on the head, principally on the eyelids, interorbital area, and snout. Juveniles and subadults may have a few cells on the dorsal surfaces of the distal segments of the limbs and occasionally a few guanophores on the back and tail. Guanophores have not been observed ventrally. They are white in color.

TABLE 18
GUANOPHORE DEVELOPMENT OF UPPER IRIS IN E. E. CROCEATOR

County	Absent	I.c.*	Slight	I.c.*	Medium
Kern (Fort Tejon)				1 j —same anim	al — 1 j
	1 s ←	—same animal—	——→ 1 s		
	1 s	2 s			
	1♂ ←	—same animal (r	ight and left eye	s)——→ 1♂	
	1♂				
		1♀	1♀	1♀	
Totals by age and sex	..	..	..	1 j	1 j
	2 s	2 s	1 s	..	..
	2♂	..	..	1♂	..
	..	1♀	1♀	1♀	..
Grand totals...	4	3	2	3	1

No individual was classed as above medium in guanophore development of the upper iris.
* Intermediate category.

Iris.—The range of variability in guanism of the upper iris appears to be similar to that of *platensis.* The distribution of individuals (10) from Fort Tejon, Kern County, for this trait is shown in table 18. As with *platensis,* a few guanophores may occasionally appear in the lower iris. Iridic guanophores may be silvery or coppery in color.

HABITAT

(Plate 15, fig. 1)

Due to the small number of individuals that have been found and the difficulty encountered in procuring them, a report, in some detail, on those discovered by the author may aid future search for this seemingly rare salamander. Animals have been taken by me at two localities: near Keene in the Tehachapi Mountains and at the type locality, Fort Tejon, both in Kern County, California.

400 yds. E Clear Creek, 50 yds. S U. S. Highway 466, 1½ mi. W Keene,

3,000 ft., Tehachapi Mts., Kern Co., Calif. Two juveniles obtained December 30, 1945. At Keene the hills are rolling, largely without rugged contours, and are covered by oak-pine woodland. The region is semiarid. Streams, such as Clear Creek, are few. Much of the erosion system of the area carries water only after storms. In summer, the region is warm and dry, not a place where one, uninitiated, would expect to find salamanders. Trees are scattered, seldom occurring in extensive close stands. Common species are canyon live oak (*Quercus chrysolepis*), blue oak (*Q. douglasii*), interior live oak (*Q. wislizenii*), and Digger pine (*Pinus sabiniana*). There is a notable lack of understory vegetation. At the time of my visit, new grass was appearing, giving the region a parklike character.

The first salamander was found under a Digger pine log, 6 feet in length and 3 inches in diameter, that rested lightly on the surface of the ground. The bark was intact and the heartwood firm. The log lay lengthways to a 45° northwest-facing slope of a ravine, about 100 feet from its bottom. Drainage was to the northeast. Grass covered the slope and bottom of the ravine. The second individual, similar in size, was found 30 feet away in the decayed wood of a Digger pine log 20 feet in length and 16 inches in diameter. The log was so decomposed that it could be dismembered easily with a shovel. It also lay lengthways to the slope. Numerous other pine and oak logs were turned but none yielded salamanders. Although the hillside where the animals were found was quite steep, there was considerable leaf litter beneath the oaks.

One mile SW Fort Tejon, 4,000 ft., Kern Co., Calif. The region is like that about Keene. The hills are rolling and grass covered with relatively little understory vegetation. However, there are no pines at the elevation of the site of collection. Digger pines can be seen along the crests of near-by ridges and yellow pine and other conifers cover the high peaks, Frazier Mountain and Mount Pinos to the southwest and west. Canyon and interior live oak are present, with an additional conspicuous element, the California buckeye (*Aesculus californica*).

December 30, 1945. Two subadults were found one mile up the southwest canyon from the Fort. They were discovered separately under oak logs beneath a clump of live oaks near the canyon bottom. The logs lay at right angle to a 35° northwest-facing slope. One measured 3 inches by 5 feet and the other (4 feet down the slope), 2 inches by 4 feet. The latter lay about 15 feet from the bottom of the canyon. There was considerable leaf litter beneath which the soil was firm. Gopher burrows were present. No water was in the ravine.

April 30, 1946. An adult female was obtained on the west slope of a north-south oriented gully 3 feet from the bottom. The ravine was well shaded by low-growing oaks and other vegetation. The salamander was found when oak leaves among green grass at the side of a trail were raked away. It lay at the base of a small oak stub, just beneath the surface litter, on relatively dry, yellow-ocher soil. The soil at other places in the bottom of the gully was much damper, especially beneath the abundant leaf litter.

A juvenile was found about 15 feet farther up the ravine, buried about 4 inches in loose, damp, soil at the base of an oak.

May 1, 1946. An adult male was obtained beneath oaks on a 45° north-facing slope several hundred feet up canyon from the site of December 30. The salamander was exposed when a dead stump was pulled out of the ground. It lay at the bottom of the cavity. There was a lush growth of grass and miner's lettuce in the vicinity.

Croceator appears to be similar in its habitat requirements to other races. It is an inhabitant of the Upper Sonoran and Transition life-zones. Animals obtained by the author have all come from the Upper Sonoran Zone but an individual found by Joseph Slevin and Wallace Wood (CAS 80560) was discovered under yellow pine bark in the Transition Zone at the head of San Emigdio Creek on the north side of Mount Pinos. The race is to be expected in Transition areas in the Tehachapi Mountains.

Although *croceator* has been known longer than any of the other members of the genus save *eschscholtzii*, it is the rarest in collections. To my knowledge only 15 specimens are in collections at present. Among the following points may be explanations for this rarity: (1) The animals may actually be scarce; with the post-Pleistocene climatic trend toward increasing dryness, they probably have become highly sporadic in occurrence, concentrated in pockets where moisture conditions are most favorable, and success in collecting depends upon finding these pockets. (2) The aridity of the region may have brought about a more completely troglodytic existence in this race than in others; the animals may be abundant but are not found because they seldom appear on the surface. (3) The region has been less thoroughly searched than most other areas; the animals may be common in the Transition Life-zone of the Tehachapi range, much of which is not readily accessible.

DISTRIBUTION

At present known only from near Keene in the Tehachapi Mountains, south to Old Fort Tejon, Kern County, California. To the north, intergradation with *platensis* begins on the south side of the Kern River drainage, in the Piute Mountains, Kern County, California. To the southeast, animals from Crystal Creek and Mill Creek Canyon in the San Bernardino Mountains, San Bernardino County, California, are considered intergrades with *klauberi*.

No spotted *Ensatina* have been found in the area between Fort Tejon and Crystal Creek, a distance, in an air line, of 115 miles. There are, however, records of *eschscholtzii* in this region. In view of the close affinity of the Crystal Creek population to *croceator*, as indicated by characters discussed elsewhere (p. 464), it seems possible that spotted *Ensatina* may eventually come to light within the gap. When one considers the small number of *croceator* obtained since Cope's description (1867), it appears plausible that the extent of the gap may be reduced by future collecting. However, in view of the sporadic distribution of *Ensatina* elsewhere in the southland, it is unlikely that it will ever be completely bridged. For a further discussion, see pp. 463 and 464.

Locality records.—CALIFORNIA: *Kern Co.*—1 mi. SW (MVZ 5/5), 1½ mi. SW (MVZ 2/2) and .8 mi N (MVZ 1/1) Fort Tejon; Fort Tejon (MVZ 3/3, CAS 1); 12 mi. W Lebec in mountains at head of San Emigdio Creek (CAS 1); 400 yds. E Clear Creek, S side U. S. 466, about 1½ mi. W Keene, 3,000 ft., Tehachapi Mountains (RCS 2/2, subsequently lost);

NOMENCLATURE

Cope (1867) described *Plethodon* (=*Ensatina*) *croceator* from a specimen—received from John Xantus—that was said to have come from Fort Tejon, Kern County, California. At one time the type, no. 4701, was in the U. S. National Museum, but apparently has since been lost. Grinnell and Camp (1917: 132) reported two specimens in the collection of the Department of Zoölogy, University of California (now in the Museum of Vertebrate Zoölogy) one of which was presumed to be the type of this species, but Storer (1929) doubted its claim to typeship. I have seen these specimens. They are not the *Ensatina* of Fort Tejon. The pattern is like that of animals from San Diego County.

Following Cope's description, until 1927, the only spotted *Ensatina* reported in California came from the Sierra Nevada; they were called *croceator*. In 1927 Klauber reported 5 specimens from San Diego County and two from the San Jacinto Mountains, collected by Frank Stephens in 1903. In 1927, a blotched salamander was found at Crystal Creek in the San Bernardino Mountains by E. Jaeger and in 1928 others were discovered in San Diego County and another in the San Jacinto Mountains. In 1929 Dunn listed two from Mill Canyon, near Banning.

Comparison of the blotched animals from southern California with those from the Sierra led Dunn (1929) to propose the name *klauberi* for the southern form, basing his description on a specimen received from L. Klauber from Descanso, San Diego County. But Storer (1929) reduced the name to synonymy under *croceator*. This left the spotted *Ensatina* of the Sierra Nevada without a name, which he supplied, calling it *sierrae*.

With the acquisition of additional material it is now apparent that the animals from Fort Tejon are distinct from those designated as *klauberi* by Dunn. The differences are well defined and constant, hence I have revived the name *klauberi* for the southern form.

INTERGRADES BETWEEN **croceator** AND **klauberi**

Ensatina which I consider as intergrades between *croceator* and *klauberi* come from Crystal Creek on the north side of the San Bernardino mountains, San Bernardino County, California, and Mill Creek[20] and Water Canyon probably from the south side of this range. Gaps in the distribution of blotched *Ensatina* lie to the northwest and south. It is not known to what extent these gaps are real. They may appear, in part, because of inadequate collecting. The San Bernardinos are separated from the San Jacinto Mountains, the northernmost locality for typical *klauberi*, by the San Gorgonio Pass and from the region of Fort Tejon, the southernmost locality for *croceator* by two low dry canyons, Cajon Pass and Mint Canyon. The San Gabriel Mountains lie between these canyons. Environmental conditions in the San Gabriels seem suited to the ani-

[20] *Ensatina* from Mill Creek and Water Canyon are considered paratypes of *klauberi* by Dunn (1929). A question arises regarding the location of these places. USGS maps give them as above Banning in the San Bernardino Mountains. In the absence of original labels on the specimens, I assume allocation of the localities to the San Jacintos by Dunn (1929:3) to be in error.

mals, but so far no blotched *Ensatina* have been found. But the mountains between Mint Canyon and Fort Tejon, aside from the bottoms of canyons and a few high points, appear wholly unsuited to them. It seems certain that if they come to light in this region, they will be found to be highly sporadic in occurrence.

The spotted *Ensatina* of the San Bernardino Mountains so completely bridge in color and pattern the differences between *klauberi* and *croceator* that there seems little doubt that their characters are the expression of recent if not a present genetic interchange between the two. If truly isolated in the San Bernardino Mountains, they must be a remnant of a once continuous intermediate population which, during Pleistocene or at some other period of greater humidity, connected the races *croceator* and *klauberi*. Thus, from a nomenclatural standpoint it seems the best expression of their relationship to consider them as intergrades.

The intermediate character of the blotched *Ensatina* of the San Bernardino Mountains is shown by (1) the dorsal markings which in shape and size resemble *klauberi* but which resemble *croceator* in usually not occurring on the upper eyelids; (2) the similarity in color of the dorsal markings, at all stages of growth, to those of *croceator;* (3) the variation in extent of light coloration of the proximal segments of the limbs which encompasses that of both *croceator* and *klauberi*. This color typically stops at the elbow and knee in *croceator* and extends beyond these joints in *klauberi*.

ANALYSIS OF COLORATION: BLOTCHING

Dorsal markings.—*Croceator-klauberi* intergrades are indistinguishable from *klauberi* except for the eyelid markings and the coloration of the dorsal blotches. The blotches are yellow or cream instead of orange.

Parotoid areas.—The parotoid marks are similar to those of *klauberi*. They are connected to form a U-shaped band on the head in 8 of the 10 animals studied. The others have a broken head band.

All individuals are like *klauberi* in having a lateral extension of the head markings on either side below the postorbital furrow. The ends of these extensions appear laterally in the gular area of 8 individuals. In *croceator* such markings are absent although 2 of 7 animals possess a small amount of light color below the postorbital furrow. All *klauberi* have such markings, although several possess a break between the lateral extensions and the remainder of the pattern, along the postorbital furrow. Such a break occurs in one of the intermediates studied.

Upper eyelids.—Seven individuals completely lack light color on the upper lids. Two possess eyelid markings covering the posterior ⅓ to ¼ of the lids and connected with the parotoid markings. A third has a 1 mm. spot medially on the right lid and one posteriorly on the left. In eyelid pigmentation, these animals favor *croceator*, since all *klauberi* studied possess light markings on the lids.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Limbs.—All individuals have uniformly light-colored proximal segments of the limbs. Four have the light color stopping at the elbow; three at the knee. The remainder are similar to *klauberi* in having light color extending beyond these joints. The animals appear to be intermediate between *klauberi* and *croceator* in the pigmentation of the limbs. All *croceator* studied have the light color stopping at the elbow and knee, whereas all *klauberi* have light color extending beyond. The intermediates exhibit both types of coloration.

Ventral surfaces.—All individuals resemble *klauberi* and *croceator* in the number and distribution of ventral melanophores. The animals segregate as follows: slight, 1 adult; medium, 5 adults; and great, 2 adults, 1 subadult, and 2 juveniles. The juveniles and, to a lesser extent, the subadults possess a reticulate arrangement of the cells. The adults lack this characteristic except one heavily marked animal that exhibits it in the postgular region and immediately anterior to the vent.

Pleuroperitoneum.—All specimens resemble *klauberi* and *croceator* in having melanophores in the lining of the body cavity.

LIPOPHORES

These cells are absent ventrally but, as in other races, are largely responsible for the color of the proximal segments of the limbs and dorsal blotches.

GUANOPHORES

As with *klauberi,* there appear to be few, if any, guanophores in the skin or iris.

COLORATION IN LIFE

A representative adult, subadult, and juvenile are described below.

Adult ♂, Mus. Vert. Zoöl. no. 42322, b. 67 mm.—Above Blackish Brown (3); dorsal blotches and proximal segments of limbs Cream Color; distal segments of limbs Mouse Gray, lightening on feet; toes dusky, marked with crossbands of lighter color at joints; below dusky white; dorsal and ventral colors grade gradually along sides; no guanophores apparent; iris apparently uniformly dark brown.

Juvenile, Mus. Vert. Zoöl. no. 42328, b. 28 mm.—Solid black above with light markings of Martius Yellow to Picric Yellow; below dusky; toes with light and dark crossbanding; no guanophores apparent in iris or skin.

Subadult, Mus. Vert. Zoöl. no. 42326, b. 40 mm.—Ground color and yellow markings somewhat lighter than in juvenile; yellow color close to light Chalcedony Yellow.

The cream color of the markings of the adults is similar to that of the blotches of adult *croceator* and an adult female *klauberi* that I have studied. Orange, however, appears to be the more typical coloration in *klauberi*. The juvenal colors closely resemble those of *croceator*. The light yellow of the subadult indicates that the color of the spots progressively lightens with growth.

Although living blotched *Ensatina* from Mill Creek and Water Canyon have not been examined, it is supposed, on morphological and geographic grounds that they will resemble in coloration the Crystal Creek animals rather than the San Diegan *Ensatina*. The specimens I have studied lack light color on the upper eyelids, the parotoid color stopping short of the lids, thereby more closely resembling the animals from Crystal Creek than typical *klauberi*. A continuous region of suitable habitat lies between these localities and Crystal Creek, whereas the less favorable San Gorgonio Pass stands between Mill Creek and the nearest locality to the south.

HABITAT

Crystal Creek above Lucerne, N side San Bernardino Mts., San Bernardino Co., Calif., May 4, 1946. Crystal Creek flows in a steep canyon on the rather precipitous north face of the San Bernardino Mountains. Although shown on USGS maps as an intermittent stream, it is claimed by residents that its flow is continuous, its source being an underground supply of water. The stream issues from a fault near the crest of the range. At the time of my visit, it averaged about 1 to 1½ feet wide and several inches deep. It is swift and rich in mineral content as indicated by an incrustation of crystalline material which has formed over all objects, including twigs, leaves, and other litter, in its bed. The sides of the canyon are rocky and in many places talus extends to the water's edge. The angle of repose of this loose material is about 45°.

There is little plant growth of a shrubby or herbaceous type among the loose rocks. The dominant tree is canyon live oak. Along the canyon bottom, often with the bases of their trunks washed by the stream, are considerable numbers of incense cedars. These trees occur in concentrations at several places on shelves where the canyon levels off and broadens out, places where one would expect better penetration of water from the stream, and in regions where the configuration of the canyon affords considerable shade. The more exposed, better-drained slopes above are covered with piñon pine (*Pinus cembroides*) and juniper (*Juniperus californicus*).

In viewing the mountain range, with its piñon-juniper cover, from the Mohave Desert at Lucerne, success in finding *Ensatina* seems very remote. The cedars and dense oak growth of the canyon bottom are hidden from view. Conditions near the stream are strikingly different from those on the dry slopes.

Three adults and one subadult were found, all confined to the damp soil that extended 3 or 4 feet from the stream. At the site of collection at 5,700 feet there was a rather dense grove of incense cedar in an almost level area. The animals were found separately beneath logs and a rock. The soil was buff colored, firm, clayey, with little leaf litter. The area was situated beneath the face of a vertical granite wall that rose about 30–40 feet above the west side of the canyon. Upstream from the cedar grove was an open, rocky, somewhat steeper area, down which the stream cascaded. It was covered in large part by *Delphinium* (past bloom). The first individual, an adult, was found when a piece of wood (10″ × 15″ × 2″) was overturned. It was curled on the hard-

packed, bare, yellow-ocher ground in a slight depression. The pale yellow blotches of the salamander closely blended with the color of the ground. A second was found in a similar site about 3 feet away; a third was 2 feet from the edge of the stream under a 3–4″ × 4′) log, which lay parallel to the creek. The animal was in a small hole beneath the log, with only its banded tail showing. The soil temperature at the collection site was 12° C., the air temperature in the shade, 5 inches above the surface, was 19.5° C. (The air temperature in the shade at Crystal Creek Ranch, 5,010 feet, ½ hour earlier, had been 30° C.) A juvenile was found among rock and wood debris close to the stream.

At 6,100 feet, about ⅓ mile farther up the canyon, a juvenile was found beneath the end of a (3′ × 3″) log which bridged the stream at the side of the trail. The soil upon which it was found was dry. The site of collection was on a 35° slope and was well illuminated at 4:00 p.m., P.S.T.

At 6,200 feet, a juvenile was found beneath a slab of wood (5′ × 8″ × 3″) on a 30° southeast-facing slope. It was resting on relatively dry soil, the temperature of which was 13° C.; air temperature in the shade was 19.4° C. The site was in a level area beneath the outer fringe of a clump of 8 or 10 incense cedars. The general aspect of the locality was strikingly similar to the one down canyon. The stream was about 10–12 feet from the southeast side of the cedar clump.

An adult was found beneath a piece of cedar bark, 8″ × 6′ × 1½–2″ near the base of one of the cedars. The soil was damper and slightly cooler (11.3° C.) than at the site where the juvenile was taken.

DISTRIBUTION

Intergrades are known only from the Transition Life-zone[21] in the San Bernardino Mountains, ranging from 5,500 to 6,200 feet. They will probably be found at elevations above and below this range and possibly may be zonally more widely distributed.

Locality records.—CALIFORNIA: *San Bernardino Co.*—Crystal Creek on N side San Bernardino Mountains, west of Cushenbury Springs, 5,700–6,200 ft. (TIS 1, MVZ 7/7); Mill Canyon near Banning, 5,500 ft. (USNM 1); Water Canyon above Banning (USNM 1).

Ensatina eschscholtzii klauberi Dunn

Ensatina klauberi Dunn, 1929:1–3, original description.

Type.—Adult female, no. 74337, United States National Museum; obtained by Joe Carter, April 1, 1928, at Descanso, San Diego County, California. Paratypes from Mill Creek above Banning, mentioned by Dunn (1929), are considered in this paper as intergrades with *croceator*.

Description.—Adult with dorsal surfaces of body and tail with large, usually rectilinear, orange blotches, often 5 or 6 mm. or more in greatest linear dimension; blotches variable in size and arrangement, sometimes distributed in checkerboard fashion, often connected to form diagonal or transverse bands, or in varying combinations of spots and bands; markings tend to be distrib-

[21] I consider the incense cedar in Crystal Creek Canyon as an indicator of this zone which here may be viewed as finger-like, penetrating the Upper Sonoran Life-zone.

uted in series on either side of midline of body, and when bands are present they seem to be composed of a pair of blotches joined medially; outlines of blotches usually regular; marks on tail often form bands; head marks consist of blotch in each parotoid area, extending a variable distance anteriorly on to upper eyelids and laterally on sides of head behind eyes; parotoid blotches may or may not be connected at midline; when connected, a U-shaped mark is formed with arms of U extending anteriorly on to eyelids; ground color deep blackish brown to black above, grading along sides into deep gray (often with purplish tinge) ventrally; melanophores present in considerable numbers on ventral surfaces; distal segments of limbs unpatterned, colored like ground color of body but somewhat lighter; joints of toes lighter than remainder of foot giving toes crossbanded appearance; light orange patch on metacarpal and metatarsal region; proximal segments of limbs orange above—lighter, sometimes yellowish, below; orange color of proximal segments usually extends beyond elbow and knee; iris dark brown, apparently without guanophores; guanophores not apparent on body.

Color changes with growth.—Juvenile solid black on head, body, and tail with sharply contrasting reddish orange dorsal blotches; proximal segments of limbs above also reddish orange, although slightly lighter than body blotches, below yellowish orange; distal segments of limbs somewhat less intense black than body; ventral surfaces deep gray; feet dusky with toes crossbanded with light and dark marks; guanophores, if present, few in number.

With growth, black coloration becomes somewhat less intense; dorsal blotches become somewhat lighter orange, becoming yellowish cream in occasional older individuals; ventral surfaces and distal segments of limbs lighten to sooty; guanophores become obscure; light areas, on upper surface of metatarsal and metacarpal regions, become more pronounced.

Diagnosis.—Distinguished from unspotted races *eschscholtzii, xanthoptica,* and *oregonensis* by presence of large blotches and bands of light color on head, body, and tail; from *picta* by light rather than dark-colored blotches and from other spotted races, *platensis* and *croceator,* by large size and greater regularity in outline of markings and tendency toward U-shaped mark on head behind eyes, the ends of which extend anteriorly on to upper eyelids and laterally often to sides of lower jaw.

ANALYSIS OF COLORATION: BLOTCHING

Body and tail.—The shape, size, number, and arrangement of the dorsal blotches on the body and tail are highly variable. They may be squarish, rectangular, oval, round, or irregular. Body markings in adults range from 3 mm. in greatest linear dimension to bands which extend across the greatest width of the body. Some individuals have a single blotch between the fore and hind limbs; others may have as many as five. Blotches may (1) alternate along the midline in checkerboard fashion; (2) form transverse bands; (3) form diagonal marks by union of slightly staggered spots, or (4) combine these arrangements. As in *platensis* and *croceator,* the markings, whether of bands, spots, or diagonal marks, have a bilateral character, arranged roughly in

linear series, a series on either side of the midline. The occurrence at the midline of a single blotch, lacking a dualistic character, is rare.

An attempt was made to classify the animals into several pattern types based on number and arrangement of blotches. The method was to group them according to 5 types illustrated in pl. 13, figs. 15–19. Some individuals were assigned with considerable uncertainty and all decisions were in varying degree arbitrary since no two animals had the same pattern. Forty-eight individuals segregated as follows:

Pattern type	*Number of specimens*
15. Few spots	6
16. Many spots	2
17. One band between fore and hind limbs	4
18. Checkerboard	6
19. Bands or diagonal marks	30

There is no correlation with respect to sex, age, or geographic position. Bands or diagonal marks are shown to be the dominant pattern type.

The markings of the unregenerated tail are usually comparable with those of the body, consisting of large orange spots, bands, or a combination of the two.

Upper eyelids.—All individuals (48) possess light color on the upper eyelids. Although none has uniformly dark-colored lids, 9 have light color on only the posterior quarter or less. Of these, 7 are juveniles (32 mm. or less in snout-vent length), one a subadult (45 mm.), and the other an adult female (68.5 mm.). Among the other well-marked animals, one juvenile (33 mm.) appears, which, on the basis of the markings of one of the eyelids, might have been classed with those mentioned above; all others have the eyelid markings about equally well developed on the two lids. It appears that with growth the marks increase in relative size. No geographic gradient is present since obscurely marked animals are distributed from Idyllwild at the northern extremity of the range to Descanso at the southern end.

At the other extreme, an adult female (59 mm.), from Cuyamaca, San Diego County, has the upper eyelids entirely light colored and an adult male (50 mm.) from Pine Hills has only the anterior edge (about 1/5) of the lid dark colored. Three adult females, a male, and 2 subadults, all from central San Diego County, have well over half of the lids light colored.

The remaining 30 specimens, ranging in size from 33 mm. to 82 mm. and geographically from Descanso to the San Jacinto Mountains, for the most part, have half or somewhat less of the upper eyelids light colored.

The eyelid pattern in most individuals appears as a continuous blotch but 7 of the 48 specimens have the markings of one or both lids broken into two or, rarely, more parts.

The eyelid blotches in *klauberi* differ from those of typical *platensis* in (1) their more regular outline, (2) their continuity with the parotoid blotches, and (3) their greater tendency toward occurrence as a single mark instead of a group of spots.

Parotoid areas.—When a U-shaped band is present, the free ends of the

mark usually are continuous with the light color of the eyelids. The mark may or may not be interrupted at the midline. It extends laterally on the head, immediately behind the eyes, for a variable distance toward the gular region. The ends of these lateral extensions may be seen marginally when the head is viewed from below. The mark usually has a fairly regular outline but occasionally it is diffuse and rather uneven. Rarely, scattered flecks of the ground color appear within it.

The head markings exhibit gradation from a continuous band, constricted only slightly centrally, through stages of increasing constriction by wedge-shaped intrusions of the ground color to a division of the mark by a faint and very narrow strip of ground color. The break in the band varies in width and may consist of a gap close to ¼ the width of the head.

TABLE 19

VENTRAL MELANOPHORES IN E. E. KLAUBERI

County	Slight	I.c.*	Medium	I.c.*	Great	I.c.*	Irregular
San Diego and Riverside	.. 1s 4♂ 1♀	2j .. 1♂ 1♀	1j 1s 3♂ 3♀	.. 1s 1♂ 1♀	6j 7s 2♂ 6♀	.. .. 1♂ ..	.. 1s 1♂ 3♀
Total	6	4	8	3	21	1	5

* Intermediate category.

Twenty-two of 48 animals have the head markings broken. In view of the unconnected parotoid marks in *croceator,* the possibility of a geographic gradient in this character was considered but it was found that individuals with widely separated marks are uniformly distributed throughout the range of the race. Likewise, there is no correlation in degree of division of the head markings with age or sex.

ANALYSIS OF COLORATION: DISTRIBUTION OF PIGMENT CELLS

MELANOPHORES

Limbs.—All but one of 48 animals studied have the light coloration of the proximal segments of the limbs extending beyond the elbow and knee to about ¼ or ⅓ the distance to the wrist and ankle. In the exception the light color stops at the elbow and knee. The remainder of the limbs are covered with a heavy network of melanophores except for the feet.

Many individuals (40) have the metatarsal region of the hind foot, usually opposite the second and third and sometimes the fourth toes, light colored. Of 8 which lack this characteristic, some show mottling of the region. The forefeet less consistently show uniform lightening of the metacarpal region but mottling is often present. The toes of most individuals are more or less distinctly crossbanded with dusky between the joints.

Ventral surfaces.—As with other races there is no geographic gradient or sexual dimorphism in this character. The concentration of juveniles and sub-

adults in the categories for heavier melanophore development is explainable in the same way as for *platensis* (page 441).

Klauberi differs from all other races that possess ventral melanophores in having them arranged in the form of a network in a large proportion of adults. There is also a tendency toward irregular arrangement of these cells resulting in a somewhat blotched appearance. In general, however, the distribution is similar to that of other races (table 19). They are not evenly dispersed over the ventral surfaces but are usually concentrated in the following places: the gular area, particularly laterally (except for breaks in some individuals due to an encroachment of the light markings of the sides of the head into this region), in the postgular area, and laterally on the abdomen. Ventral stippling is usually light or absent on the posterior part of the gular region along the edge of the gular fold, the chest, a central longitudinal area on the body, the pelvic region, an area immediately surrounding the vent, and a narrow longitudinal zone beneath the tail. The melanophores of the abdominal and pelvic areas are sometimes clumped, forming irregular blotches. Such spots sometimes also appear on the underside of the hind limbs.

Pleuroperitoneum.—All individuals (41) have melanophores in the lining of the body cavity. Thirty-six (87.8 per cent) have light to medium, and the remainder (12.2 per cent) heavy development of these cells.

LIPOPHORES

These cells were absent ventrally in the 5 living animals seen by me. As in other blotched or spotted races, they are in large part responsible for the color of the proximal segments of the limbs and dorsal markings. In *klauberi* they are also found dorsally in the metapodial areas. Their color is orange in most individuals but a change may occur, seemingly related to aging, as indicated by a large animal with cream-colored markings.

GUANOPHORES

It appears that these cells are lacking both in the skin and iris. More living individuals are needed for study of guanophore development.

HABITAT

From December 17 through 21, 1945, my wife and I looked for *Ensatina* in the mountains of central San Diego County, California, from Alpine to Pine Hills. The area investigated lies along the crest of the range. To the east the mountains slope toward the Colorado Desert, and 45 to 50 miles to the west lies the Pacific Ocean. It is the "high country" of San Diego County. In general, the hills are rolling, without rugged contours, although to the south, in the vicinity of Descanso and Alpine, numerous, often pillar-like, granitic rock outcrops appear.

Zonally, the area consists of an intermixture of Transition and Upper Sonoran. On the high points and in canyon bottoms and on north-facing slopes, yellow pine, incense cedar, white fir, and black oak predominate. Coulter pine (*Pinus coulteri*) and canyon live oak are also found. Intervening areas, such

as at Inspiration Point, may exhibit Upper Sonoran conditions with manzanita (*Arctostaphylos* sp.), toyon (*Photinia arbutifolia*), scrub oak (*Quercus dumosa*), *Ceanothus*, white sage (*Salvia apiana*), and buckwheat (*Eriogonum fasciculatum*). In some areas, as about Pine Hills and Julian, there is much open grassland with a broken Transition forest.

In many places were numerous rocks, logs, and considerable leaf litter, providing ample cover for surface activity of *Ensatina*. The soil was reddish brown or buff and black where rich in humus. The colors of *klauberi* harmonize well with the soil and leaf colors. Details relating to the collection of individuals follow.

11 mi. NE Descanso, 150 ft. NW State 79, San Diego Co., Calif. Adult ♀, Mus. Vert. Zoöl. no. 41795, collected by author, December 18, 1945. The salamander was under a *Ceanothus* stump which lay uprooted and on its side. The stump measured 16 inches across the bole and 3½ feet from the tip of the longest root to the end of the shattered trunk. The animal lay in a shallow depression in the soil into which it fitted closely, suggesting that it had made the excavation. The earth was buff-colored and dry, almost powdery. Other places beneath the log were damper. The temperature of the soil at the collection site was 4° C.; the air temperature in the shade, 10 inches above the surface, was 8° C. The only other animal seen under the log was a centipede.

The site was on a 20° northeast-facing slope of a shallow ravine that drained to the northwest. Incense cedar and canyon live oak were the dominant trees. The salamander was procured 25 to 30 feet down slope from the base of a clump of canyon live oak trees. There were scattered logs and rocks upon and partly embedded in a thick mat of leaf litter. At the time of collection, 11:45 a.m., there was a high uniform overcast. Snow patches were still present from a storm 2 weeks previously.

9.7 mi. NE Descanso, 15 ft. SE State 79, San Diego Co., Calif. Juvenile, RCS 521, collected by author, December 18, 1945. The salamander was found under a water-worn boulder (about 15″ × 12″ × 5″) on the rocky west bank of a small stream, about 5 feet above the creek. The stream was about 4 feet wide and 4 or 5 inches deep, and flowed to the south. The soil at the site was black sandy loam interlaced with roots of a honeysuckle. Its temperature at 2:00 p.m. was 4° C. and the air 10 inches above the surface, in the shade, 10° C.

The area was well shaded by alder (*Alnus rhombifolia*), incense cedar, honeysuckle (*Caprifoliaceae*) and wild rose (*Rosa californica*). Yellow pine and coast live oak were also present. Many of the rocks were moss covered. Among them was considerable leaf litter, in some places 3 or more inches thick. Many of the leaves exhibited colors like the spots and bands of *klauberi*.

¼ mi. NE Julian, San Diego Co., Calif. Adult female (?) found by P. Krutzsch, Aug. 31, 1946. Mr. Philip Krutzsch, the collector, provides me with the following information: A large adult with stout tail (probably a female) and orange spots was found crawling along the dusty floor of a mine tunnel, one of a number in the Eagle Lode Mine. The tunnel was on a southeast-facing slope. Its opening was overgrown with poison oak (*Rhus diversiloba*). Vegetation in the area consisted of yellow pine, Jeffrey pine (*Pinus ponderosa*

var. *jeffreyi*), and black oak, with manzanita as understory vegetation. Mountain mahogany (*Cercocarpus* sp.) was present also.

The salamander was about 50 feet from the entrance. At 2:30 p.m. the air temperature of the tunnel was 10° C.; that outside 25° C. Although the ramifications of the mine were thoroughly searched, no damp soil could be found.

The general habitat requirements of *klauberi* do not appear to be significantly different from those of other members of the species.

DISTRIBUTION

Klauberi ranges from the San Jacinto Mountains, Riverside County, south to Pine Valley, San Diego County, California. Most of the localities where it has been taken are in the Transition Life-zone but several are in Upper Sonoran areas. Alpine and Descanso are characterized by coast live oak with chaparral on the adjoining hills.

Locality records.—CALIFORNIA: *Riverside Co.*—San Jacinto Mts. (SSNH 2); Idyllwild, about 5,400 ft., San Jacinto Mts. (SSNH 2, CAS 1). *San Diego Co.*—Palomar Mt. (CAS 5); Lower Doane Valley, Palomar Mt., 4,800 ft. (SSNH 2); Rose Mine, about 1 mi. N Big Laguna in Laguna Mts. (Klauber, 1927);[22] Laguna Mts. (CAS 1); Oakzanita, Rose Mine, Laguna Mts. (CAS 1); Laguna Hanson Mts., 55 mi. SE San Diego (Storer, 1929); Cuyamaca Mts. (SSNH 2); Cuyamaca (LMK 4); Cuyamaca Lake [4,700–4,800 ft.] (LAM 1); on hillside directly W Cuyamaca Lodge, 4,900 ft. (MVZ 1/1); Descanso (LMK 3, SNHM 1); 3 mi. NE Descanso, 3,700 ft. (Klauber, 1927); 11 mi. (MVZ 1/1) and 9.7 mi. (MVZ 1/1) NE Descanso on State 79; Hot Springs Mt. near Warner's Hot Springs, about 4,500 ft. (Storer, 1929); Pine Valley, about 3,900 ft. (SSNH 1); Julian, about 3,900 ft. (LMK 2, MVZ 1); ½ mi. W Julian (MVZ 1); State 79, 11.7 miles (MVZ 1/1) and 11.9 mi. (MVZ 1/1) S junction State 78 and 79 S Julian; Pine Hills (LMK 9, SSNH 1); Alpine (LMK 3).

Cope's record (1889: 151) of *Plethodon* (=*Ensatina*) *croceator* from Cape San Lucas, Lower California, has been considered erroneous by Van Denburgh (1916: 220–222) and Storer (1929: 447). In view of the occurrence of *croceator* (=*klauberi*) in live oak–chaparral areas, as at Alpine in San Diego County, California, its occurrence in the Cape region of Lower California seems possible. It is probable that *klauberi* and perhaps *eschscholtzii* will be found in northern Lower California. Search should be made in the Sierra San Pedro Mártir.

NOMENCLATURE

See page 463.

KEY TO SUBSPECIES

1a. Body uniformly colored above, in life blackish brown, brown, or reddish brown......2

1b. Body not uniformly colored above, with dark or light-colored blotches.............4

2a. Iris dark brown, without yellow, copper, or silver coloration; feet whitish; venter white, without numerous black stipple marks; dark pigmentation (melanism) of sides usually even with or above line connecting bases of upper surfaces of limbs. *Range.*—Coastally, from extreme southern San Diego County to southern San Luis Obispo County, California, and interiorly at least to Forest Home in the San Bernardino Mountains and Indian Canyon in the San Jacinto Mountains........... *E. e. eschscholtzii*

[22] Lockington (1880) reports a salamander collected by Mr. E. R. Dunn and Mr. W. J. Fisher in 1876, and identified by Cope as *Plethodon* (=*Ensatina*) *croceator*. The locality given is "a district about 75 miles southeast of San Diego." Klauber (1927) thinks that this station was probably near Laguna Hanson, 77 miles southeast of San Diego. Dunn (1926) had ascribed the specimen to the Sierra San Pedro Mártir of Lower California.

2b. Iris with yellow, copper, or silver color (light eye color may be absent or whitish in preserved specimens); venter with varying amounts of black ventral stippling; dark pigmentation (melanism) of sides usually extends below line connecting upper surfaces of bases of limbs..3

3a. Venter uniformly orange (in life) with black ventral stipple marks absent or scarce, when present tending to be clumped; yellow eye patch well developed but often lost with preservation; melanophores of sides of body not notably irregular in distribution; entire proximal segments of limbs and upper eyelids light colored in many individuals. *Range.*—From central Napa and southern Sonoma counties, north of San Francisco Bay, south to central Santa Clara County, California; Jawbone Ridge, Tuolumne County, in the Sierra Nevada of California.............*E. e. xanthoptica*

3b. Venter whitish or with faint scattered spots of orange or yellow; ventral stippling uniform; eye patch less well developed; melanophores of sides of body usually irregular in distribution, producing mottled effect; usually only basal ½ or ⅓ of upper surface of proximal segments of limbs light colored; eyelids dark. *Range.*—From British Columbia south in the coastal mountains to northern Mendocino and Sonoma counties, California, except for range of *picta*..........................*E. e. oregonensis*

4a. Above with dark blotches of varying size, shape, and abundance...............7

4b. Above with light-colored spots or blotches (reddish orange to yellow in life) on dark brown to black ground color...5

5a. Spots small and numerous; no definite parotoid blotches or U-shaped band on head; distal segments of limbs spotted. *Range.*—Confined to the southern Cascades and the Sierra Nevada of California..................................*E. e. platensis*

5b. Spots larger, less numerous; definite blotch in each parotoid region or U-shaped band on head; distal segments of limbs uniformly dark colored, not spotted.............6

6a. Light-colored U-shaped mark on head, with arms of U reaching eyelids; central portion sometimes interrupted, forming distinct parotoid blotches; lateral extension of head marking passing below postorbital furrow, sometimes to lateral gular area; eyelids nearly always with light-colored marks; large rectilinear blotches, bars, and bands on body and tail; markings usually orange in life. *Range.*—Mountains of western Riverside and central San Diego counties, California......
E. e. klauberi

6b. No U-shaped mark on head; a distinct blotch in each parotoid area, usually without a lateral extension on side of head; eyelids typically unmarked; spots on body smaller, more irregular in outline, and usually not rectilinear; markings usually yellow in life. *Range.*—Tehachapi Mountains south of Kern River Valley and vicinity of Mt. Pinos, Kern County, California..................*E. e. croceator*

7a. Ventral surface of body essentially without stippling of melanophores; in life, no light color in eye or orange or yellowish color on ventral surface of body (underside of limbs and tail excepted).....................................*E. e. eschscholtzii*
(Some individuals from the San Gabriel and San Bernardino mountains, California.)

7b. Ventral surface of body with uniform and numerous melanic stipple marks; in life, yellowish to bronze patch in upper iris; venter with varying amounts of orange or yellow coloration. *Range*—Confined to a narrow coastal strip in northern California and southern Oregon......................*E. e. picta* and juvenal *E. e. oregonensis*
(Range does not apply to latter.)

ECOLOGY

In a later paper I propose to treat the subjects of habits and ecological requirements of *Ensatina eschscholtzii*, but a brief résumé is desirable at this time to support remarks regarding variation and evolutionary trends. Most of my comments will be confined to the species in California since I lack adequate field experience in Oregon and Washington.

Ensatina is an inhabitant of the Upper Sonoran, Transition, and lower Boreal life-zones in the mountainous areas of the State. It does not seem to occur naturally in the Lower Sonoran Zone; high temperatures and low humidity apparently preclude its existence there. It appears to be of limited occurrence in the Boreal Zone where winter temperatures are probably unfavorable. Its manner of occurrence within the zonal range indicated is influenced by a number of factors, some of which are discussed below.

In the southern part of the State, the species seems to be largely a canyon dweller. In drier regions, the animals tend to select north-facing slopes and deep canyons where temperatures and conditions of humidity are favorable. Greatest concentrations of individuals are likely to occur on flat or gently sloping benches, above flood level, rather than on steep slopes. A perennial stream is often present although it is not a necessity, since individuals have been found miles from water. In northerly areas, the species is more widely distributed, frequently occurring on ridges as well as in the canyons.

Ensatina frequents areas where there is considerable leaf litter. A leaf mat acts as an insulating blanket helping to conserve the moisture of the substratum and buffering temperature fluctuations. It is sought not only as a place of refuge but also for the insects, spiders, crustaceans, and earthworms that occur in or beneath it and that serve as food.

These salamanders are capable of digging only to a limited extent by wriggling into leaf litter or loose soil. They cannot burrow into firmly packed ground. During dry weather, they may be forced to retreat to considerable depths. Thus they tend to frequent areas where there are holes in the ground such as rodent burrows, rotted-out root channels, and openings among rocks.

When the surface is damp and temperatures not too high, considerable time is spent above ground where most feeding probably occurs. The presence of surface objects under which insects, spiders, and other prey may hide is a common feature of the habitat. The salamanders may be found under boards, logs, rocks, in refuse heaps, leaf litter, under bark, and inside logs.

The species occurs in association with a variety of plants, but some kinds are more often present than others. In Transition areas, common species are the coast redwood, Big Tree, incense cedar, canyon live oak, black oak, Douglas fir, white fir, and yellow pine. In the Upper Sonoran Zone, coast live oak, bay, madrone, wild black walnut, and Digger pine are often found. In both zones the trees mentioned may be present in pure stands or in varying combinations.

Understory vegetation is often scarce, particularly in more northerly areas where the animals occur in dense forests. Such growth may interfere with surface movements and thermal requirements for feeding and other activities. Colonies seem best developed in marginal belts between dense and sparse vegetation, in "edge" situations. Thus, in redwood stands, they may occur in areas of interdigitation with coast live oak, bay, and madrone, or in patches of tan oak, of local occurrence within the redwood forest. Advantages can be seen for such selection. The dense growth and continual shade of the conifers permits prolongation of activity with the passing of the rainy reason and the approach of summer, and the deciduous vegetation allows greater insolation

in winter and hence more favorable temperatures for surface activity at this season.

Tentatively,[23] the annual cycle of activity of an *Ensatina* colony in California may be sketched as follows:

With the first soaking rains in the fall or winter, animals of all sizes, including newly hatched young, emerge from their summer retreats. In some areas, considerable dehydration may have occurred during the dry period and feeding may have been limited. The movement to the surface makes possible replenishing of water by dermal absorption and resumption or increase in feeding.

Surface activity continues while temperatures and moisture conditions are favorable, which may last until late spring or early summer, even in southern areas. At high elevations and in the north there may be considerable depression or complete cessation of activity in winter, the animals being driven underground by freezing temperatures. Winter decline is, of course, less marked to the south.

Most breeding appears to occur in early spring, in February and March. At this time adults are commonly found in pairs. After a period of a few weeks, numbers of adults drop off rapidly. Their disappearance is probably related to reproductive activities—selection of a nesting site, egg laying, and attendance[24] upon the eggs. The young remain longest on the surface. Perhaps their growth requirements impel them to prolonged feeding.

Curiously, for an animal so dependent on moisture and temperature conditions, the eggs are laid sometime in spring or early summer, with incubation taking place during the dry period. Probably temperatures for development are most favorable at this time. Moisture conditions are met by selection of the nesting site and possibly by discharges from the bladder and skin of the adults. The time of hatching is not known. The smallest young, however, appear with the first rains in the fall or winter.

Ensatina seems to be colonial in habit, particularly in the south, where conditions of temperature, humidity, and vegetational features are quite variable. Some of the smaller colonies seem to be almost wholly panmictic, a reproductively active male having an equal chance of meeting any breeding female. There is no indication of territorial behavior. Several males may occur together, and their relative positions within the population may shift. That home areas may exist, at least for some individuals, is suggested by an adult female in a marked population that appeared under the same board a year following the first capture.

With respect to movements of individuals, an important agency of dispersal should be pointed out. The tendency for the animals to congregate in the bottoms of canyons, particularly during dry weather, places them in a position to be transported by stream action during storms. I have repeatedly observed individuals under water-borne debris along roads at the mouths of canyons.

[23] Based on a preliminary analysis of data accumulated on marked populations.

[24] The few egg clusters that have been found (5) were attended by the female and in one instance the male was present also.

Ensatina can tolerate complete submergence for several hours and some individuals may survive in water for considerably longer periods. Upon removal from water, if still alive, they usually revive in a few minutes. Thus, conceivably an individual could be carried many miles and then be cast ashore to become established in an area far removed from its homesite.

Direction of drainage thus assumes a role of importance in rate of dispersal in the species. Other things being equal, movement of individuals along the long axis of a mountain system with transverse drainages would be slower than along a range with longitudinal ones. An example of the former is the Sierra Nevada, and of the latter some parts of the coast ranges. May such topographic differences have bearing on the size of areas of intergradation along the coast as compared with that of the Kern River drainage of the Sierra Nevada?

ANALYSIS AND SUMMARY OF VARIATION IN THE SPECIES

In preceding pages intra- and interracial variation have been analyzed in considerable detail. Attention is now focused on broader aspects of variation that emerge when the species is considered as a whole. The color characters discussed at length earlier are found to show marked trends, some of which can be correlated with environmental gradients. Summaries of age and sex variation are presented first.

Character Changes with Age

In general, young tend to resemble adults in coloration. This is true of juvenal *klauberi* and *croceator* among the interior spotted races, and *eschscholtzii, xanthoptica,* and *picta* among the coastal subspecies. Young *oregonensis* and *platensis,* however, differ considerably from the adults: *oregonensis* in being dark blotched—like adults of the race *picta*—and *platensis* in being unicolored or vaguely spotted. Young intergrades between *oregonensis* and *platensis* are uniformly black above, except for the proximal segments of the limbs—differing from the adults in lacking orange spotting and blotching.

Young of all races have a heavier sprinkling of guanophores than do adults. However, the same relative differences existing among adults of the various races are found in the young. Perhaps of significance, from the standpoint of relationships, is the tendency toward a *picta*-like distribution of these cells in *oregonensis-platensis* intergrades and in *platensis.*

With increase in size the general trend coastally is toward darkening of the melanic coloration; and in the blotched young of *oregonensis* and *oregonensis-xanthoptica* intergrades there is more uniform distribution of melanin, accompanied by loss of blotching. There is increase in number of lipophores and a general deepening of the lipoid colors. In the interior spotted races, including *oregonensis-platensis* intergrades, the trend in intensity of melanism is reversed. There is slight lightening of the melanic ground with age. In the races *croceator* and *klauberi* and their intergrades, there is also lightening of the lipophore coloration of the dorsal spots.

The proportions of young animals are quite different from those of adults. The head and eyes are considerably larger, the body stockier, and the tail shorter and without a well-marked basal constriction. The sexes are indistinguishable externally. The secondary sexual characters of forking of the nasolabial groove and of differences in tail length and thickness do not appear until adult size is approached.

Sex Differences

Secondary sexual characters are not conspicuous. In view of the apparent absence of sexual dimorphism other than that indicated beyond, extensive

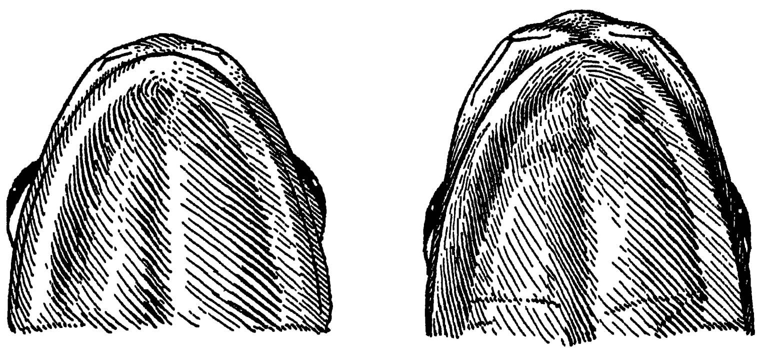


Fig. 10. Sexual dimorphism in the form of the upper lip and nasolabial groove in *Ensatina eschscholtzii*, ventral aspect. (1) female; (2) male.

investigation of such variation was not made. Study of sex differences in the race *eschscholtzii* has been used as an index to dimorphism in the species as a whole.

Males of *eschscholtzii* have longer and more slender tails than females, the tail closely approaching, equaling, or exceeding the snout-vent length. Females usually have tails that are slightly more than three-fourths the body measurement.

There is a sexual difference in the nasolabial groove, males having more pronounced forking and greater enlargement of the upper lip than females (text fig. 10). The lip enlargement seems to be associated with glandular development accompanying the grooves. It gives the snout of males a more truncate aspect.

Males have a somewhat more protuberant cloacal region than females and, like other plethodontids, differ in having villose rather than smooth or pleated lateral walls within the cloacal orifice.

No general sexual dimorphism has been found in coloration. The only suggestion of a color difference in the species appears in *platensis* from the southern part of its range (p. 438).

Although it is possible that other races may possess sexual differences other than those found in *eschscholtzii*, these differences, if present, must be slight. None was noted upon casual examination, although the differences cited above can be seen in all subspecies.

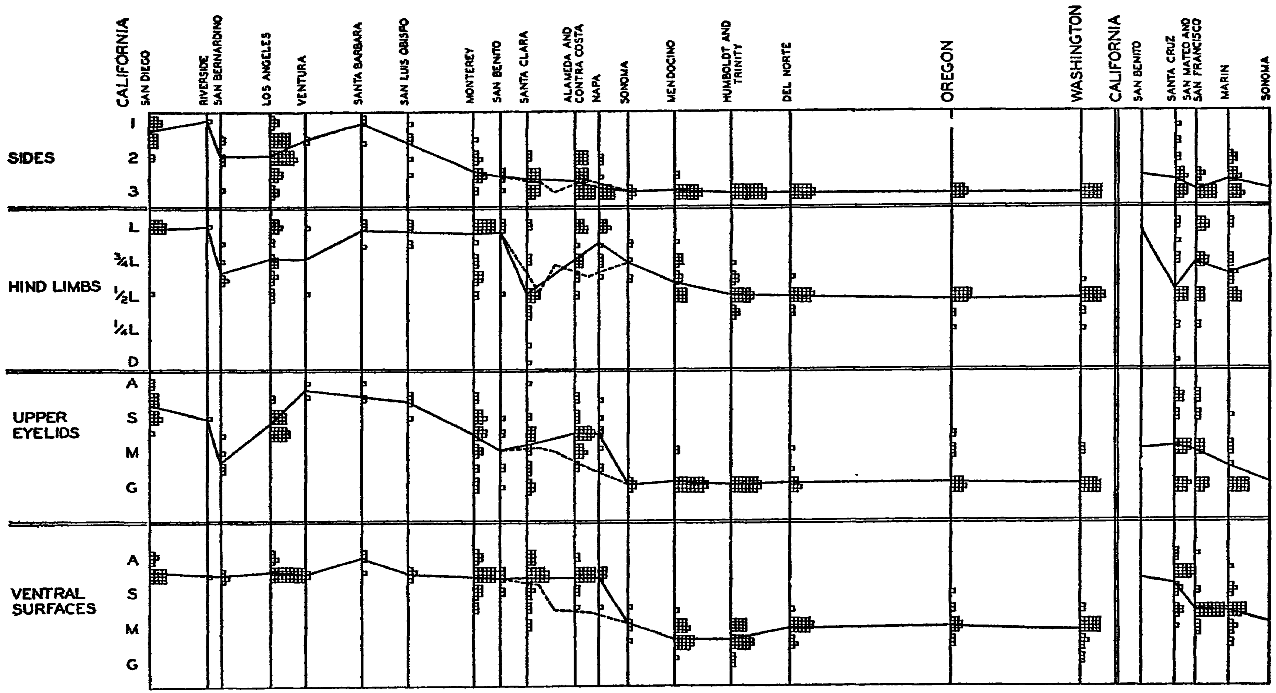


Fig. 11. Trends in melanophore development in coastal populations. Animals are grouped by counties. A vertical line represents roughly the geometric center of each county, spaced to scale geographically. In the absence of sex and size variations, all individuals are represented by the same symbol, an open square. See standards, figs. 3, 4, and 5 (pp. 386, 388, 389), for meaning of numbers and letters on the left. Note the trend toward lightening to the south.

The dotted line is a duplication of that showing trends in animals from areas west of San Francisco Bay, segregated on the right for clarity. The solid line follows east-Bay trends. The two lines unite north and south of the Bay.

Geographic Variation

Major gradients are seen in the long, relatively narrow, north-south areas of distribution that characterize the species. Most study has been directed toward these latitudinal trends. Altitudinal gradients have been given much less consideration, principally because of lack of adequate material.

Latitudinal Trends

COASTAL RACES

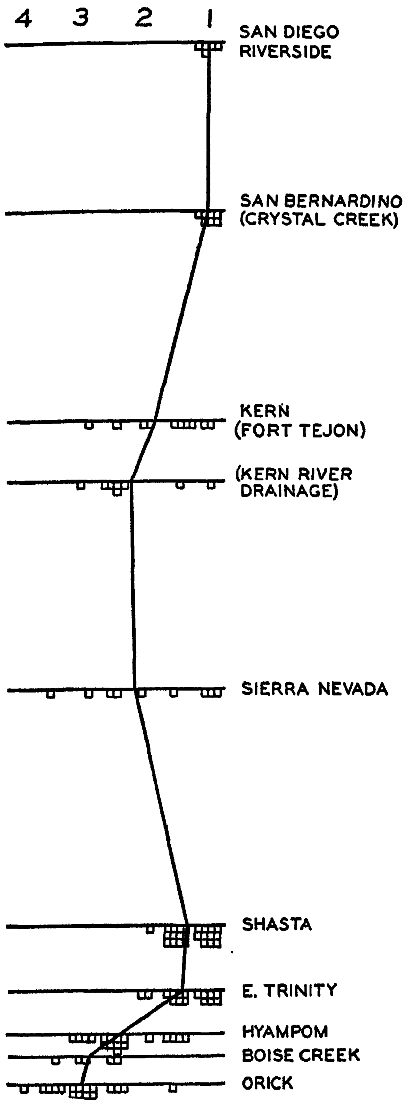
(*Oregonensis, picta, xanthoptica,* and *eschscholtzii*)

Pigmentation.—Blotching: *picta,* in addition to being a dwarf race, is characterized by varied development of dorsal melanic blotching. This feature, however, is not limited to it, but appears in varying degrees in adjoining populations. There is gradual loss of the dark markings to the north and south, the persistence of the character being correlated with size. Radially from the zone of heavy blotching, increasingly smaller individuals lack the markings until only the young are blotched. In northern Oregon and Washington and to the south, west of San Francisco Bay, blotching is largely restricted to juveniles. In the area east and south of the Bay it is absent.

Melanophores.—Text figure 11 summarizes changes in abundance of, and extent of areas possessing, melanophores. All changes show the same major trend, namely, a decrease in number of melanophores and in areas marked by them to the southward. In the north, where environmental conditions are relatively uniform, the melanic characters show slight change, but in Mendocino and Sonoma counties, California, the beginning of melanic decline is noted and to the south variability increases. This increase is correlated with greater zonal variety. The differences in the animals west and east of San Francisco Bay are related to such life-zone differences, Transition predominating in the former, and Upper Sonoran in the latter. A similar relationship exists in the sharp increase in melanism in the Transition Life-zone in Los Angeles and San Bernardino counties.

Disregarding the blotched race *picta,* the changes that occur in depth of color of the melanic ground are as follows: *Oregonensis,* in the northern part of its range, is moderately dark colored with a tendency toward minute breaks in the melanic network. To the south, the continuity of the network and depth of pigment increases, reaching its peak near the southern limit of distribution of the race, in northern California. Farther south, there is steady decline in intensity of melanism, dark coloration tending to persist, however, in Transition areas. At the southern extreme of the species range, melanism is weak and the melanic network may be extensively broken.

Lipophores.—There is a comparable major gradient from north to south in ventral lipophore development, but superimposed upon it are several subsidiary ones. There appears to be a decline at the extreme north and an accentuation in the zone occupied by *picta.* Maximum development is reached in the race *xanthoptica.* South of San Francisco Bay, there is gradual diminu-



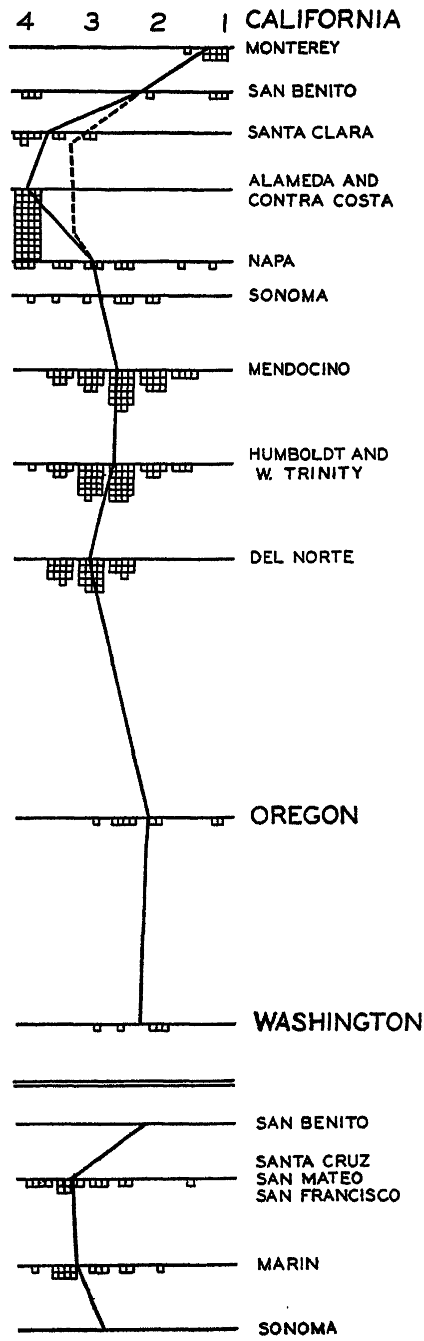


Fig. 12 (*Left*). Variation in iridic guanism traced, top to bottom, from southern California through the Sierra Nevada, then to the coast. Horizontal lines are roughly spaced to scale geographically. No sex or age differences have been found, hence all individuals are represented by the same symbol.

Fig. 13 (*Right*). Variation in iridic guanism traced in coastal populations from Monterey County, California, into Washington. (1) indicates absence of guanophores; see fig. 6, page 391, for meaning of other categories. Counties are roughly spaced to scale geographically. Those in the area west of San Francisco Bay are treated separately, below the double line, and the trend is shown as a dotted line near top.

tion, with lipophores finally appearing only on the limbs and tail south of Santa Barbara County.

The trend in coloration is from pale yellowish orange in the north, through orange in the Bay area of California to reddish orange south of the Bay.

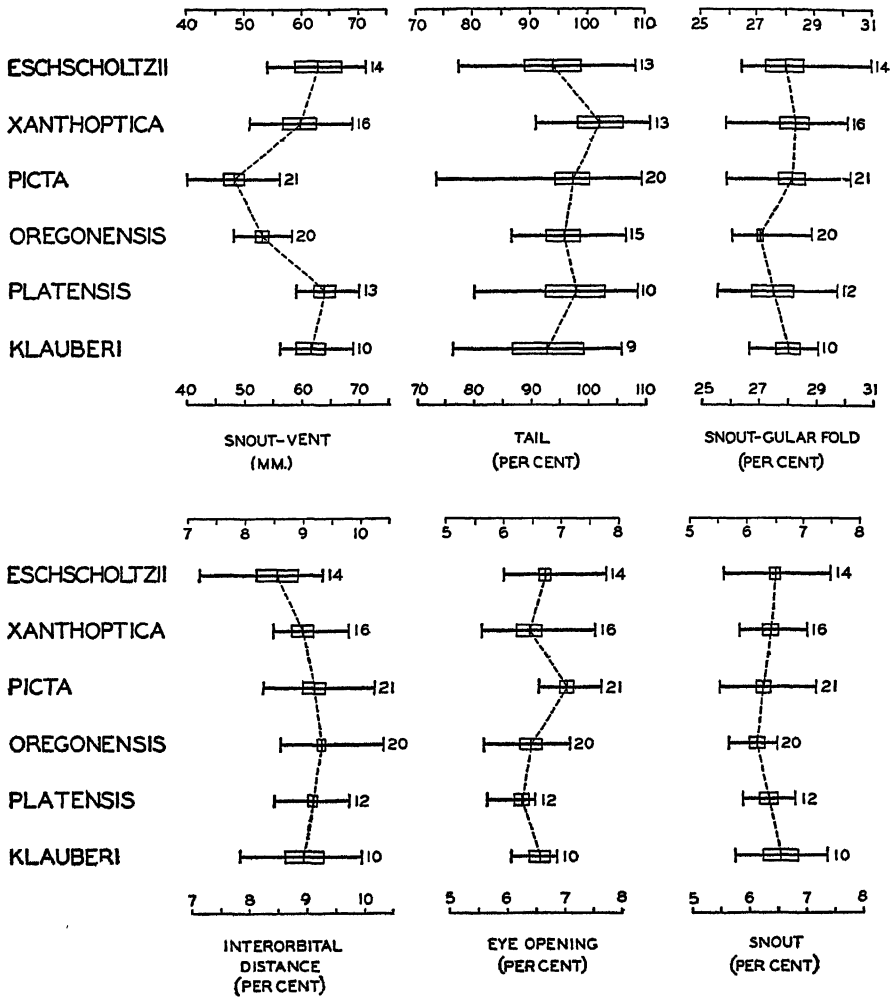


Fig. 14. Variations in size and proportions in subspecies of *Ensatina eschscholtzii.* The method of comparison is that devised by Dice and Leraas (1936). The race *croceator* has not been included because of insufficient material. Dotted lines connect the means. The lines to right and left of the mean are twice the standard error. If the rectangles do not overlap, differences are statistically significant. The number to the right of each horizontal line is the number of specimens used in the analysis. The length of this line gives the range in variation. Only adult males were used. Figures for proportions are percentages of the snout-vent length. The snout-vent measurements, however, are absolute.

Guanophores.—The basic tendency in guanophore development of the skin parallels that of the ventral lipophores. Subsidiary trends differ, however. Maximum development seems to be reached by *picta* and adjoining populations in northern California, with decline occurring to the south. A step cline

may exist south of the Bay. The few animals available suggest rapid loss of these cells in the vicinity of the Salinas Valley.

In text figure 13, variation in the degree of development of the guanistic eye patch is shown. The direction of this variation tends to follow that of the ventral lipophores, with *picta* and *xanthoptica* having well-developed iris patches. A difference lies in the sudden loss of the patch south of San Francisco Bay.

Skin and iridic guanism parallel one another except in the east-Bay area where the latter reaches maximum development.

Size.—The following remarks on size and proportions are based on adult males only. The smallest race is *picta*, adult males of which are only slightly over two-thirds the size of the largest coastal subspecies, *eschscholtzii* (text fig. 14). It is not, however, the most northerly form. It is by-passed to the east by *oregonensis* which ranges into southwestern British Columbia. Ignoring *picta*, a gradual gradient of increasing size is present from north to south. The small size of *picta* will be commented upon later.

Proportions.—Tail: the ratio of tail length to body length shows no interracial differences except possibly for *xanthoptica*. In this race, the tail in males borders on being significantly longer than in the others. Snout: *oregonensis* has the shortest snout of the coastal series. Eyes: there is a north-south gradient in eye size, *oregonensis* having smaller eyes than *eschscholtzii*. *Picta*, however, in addition to being smaller than the other races, further deviates from major trends in having a larger eye opening. Measurements of the interorbital distance support observations on the size of the opening as an index to eye size. This distance becomes smaller to the south, presumably with increase in size of the eyeball. In this character, however, *picta* fits into the north-south gradient.

INTERIOR RACES

(*Platensis*, *croceator*, and *klauberi*)

Pigmentation.—Spotting: the outstanding difference between the coastal and interior races is the presence of dorsal light-colored spots or blotches in the latter. This spotting shows a major north-south trend, with spots increasing in size and regularity of outline toward the south. In the southern Sierra, however, in the vicinity of Sequoia National Park, there seems to be a local difference, many individuals appearing with extensive, although irregularly outlined blotches, which approach in size those of *klauberi* at the southern extremity of the range.

Trends may be seen in details of the blotching. They are: (1) loss of spots on the distal segments of the limbs and the development of light areas on the feet in populations well to the south; (2) a tendency toward arrangement of dorsal spots in two longitudinal series with the appearance of transverse banding in the terminal race *klauberi*; (3) disappearance of light-colored markings on the eyelids in *croceator*, but reappearance in the race *klauberi*; (4) grouping of head spots to form parotoid markings in *croceator*, which, in the race *klauberi*, join to form a head band in about 50 per cent of the population—in keeping with the general tendency toward banding in this race.

Melanophores.—There is considerable uniformity in the distribution and arrangement of the melanophores. The ventral surfaces are rather evenly sprinkled with them; the ground color of the upper eyelids is consistently dark brown to black and there is gradation along the sides between the dorsal and ventral pigmentation. There is, however, a north-south gradient in melanophore development of the limbs. These cells recede distally, with increasingly more of the basal portion of the limbs lacking them.

In depth of color of the dorsal melanic ground, there is a reversal of the trend found in the coastal races. The ground color in *klauberi*, the southernmost race, is black, or nearly so, whereas *platensis*, to the north, averages somewhat lighter.

Lipophores.—Ventral lipophores are rapidly lost in the zone of intergradation with *oregonensis* and are absent ventrally, except occasionally on the underside of the limbs. Lipophores in the dorsal spots and on the proximal segments of the limbs show change in color. The dominant hue in *platensis* is orange-red. In *croceator* and intergrades with *klauberi* the color changes to pale yellowish cream or yellow. Reddish orange appears again in *klauberi.*

Guanophores.—Little information is available on skin guanism, but the interior races, like the coastal series, seem to show a decline toward the south. Iridic guanophores, following a marked decrease in the zone of intergradation with *oregonensis*, become more abundant in *platensis*, but show a decline again in *croceator*, and finally apparently disappear to the south (text fig. 12, p. 481). More animals are needed to determine fully the nature of this character gradient.

Size.—The following comments on size and proportions are based on measurements of adult males only. There appears to be no north-south gradient in size, the interior series resembling *eschscholtzii* and *xanthoptica.*

Proportions.—The interior races resemble *eschscholtzii* and *xanthoptica* of the coastal series in tail length, the range in variability embracing the possible difference between the two. *Klauberi*, like *eschscholtzii*, is greater in snout length than *oregonensis* and, like all others except *platensis*, is greater in snout to gular fold measurement. In size of eye opening, *platensis* differs from *eschscholtzii*, *klauberi*, and *picta* in having a smaller aperture, but resembles *xanthoptica* and *oregonensis* in this character. In interorbital distance *platensis* is similar to the others except for *oregonensis*, which exceeds it, and *eschscholtzii* which is smaller than *platensis.*

Altitudinal Trends

There is little material available for study of altitudinal trends. The most suitable animals come from southern California where there are sharp zonal changes with altitude. Animals from the Upper Sonoran Zone in the Santa Monica Mountains have been compared with those from the Transition Zone in the San Gabriel and San Bernardino mountains. This comparison reveals a parallel with changes that occur latitudinally. There is increase in extent of areas marked by melanophores and apparently decrease in body length at higher elevations. Curiously, however, deepening of melanism, as found in

animals from redwood areas to the north, is not noticeable. An altitudinal increase in melanin had been anticipated in view of the observations of Myers (1939) on *Ambystoma tigrinum* in Colorado, where darkening of this species occurred at high elevations. Rather, montane *Ensatina* from southern California, closely resemble *oregonensis* of the Douglas fir zone in Oregon and Washington. The pale orange lipophore coloration also corresponds with that of northern *oregonensis*. This convergence is doubtless related to parallelism in environmental gradients, similar trends occurring with increase in altitude as with increase in latitude.

CORRELATION OF CHARACTERS

Characters that Change Together

In the coastal series, several characters change together. This is true of the melanic features, all of which tend to follow one another closely. Iridic and skin guanophores also parallel one another. Ventral lipophores and iridic guanophores change together over much of the range, but south of San Francisco Bay the rate of decline in the two is different. Disregarding *picta,* there is gradual increase in size correlated with increase in snout length and eye size to the south.

In the interior races, although melanic characters are relatively uniform, several correlations are present. There is southward darkening of the melanic ground with increase in size of dorsal areas free of melanophores. Increase in size of markings is correlated with greater regularity of their outline and a tendency toward transverse banding of the head, body, and tail. Darkening of the melanic ground, enlargement of spots, and greater regularity of outline of the markings are correlated with a tendency toward lightening of the lipoid color of the markings. Changes in iridic and skin guanophores correspond to those of the coastal series. The correspondence breaks down, however, in the zone of intergradation between *oregonensis* and *platensis*. Here, iridic guanism is much reduced, while skin guanophores approach maximum abundance.

Morphological Parallelism Between Coastal and Interior Races

The interior series of races exists in a more uniform environment than the coastal series, through its essential adherence, by altitudinal adjustments, to the Transition Zone. Nevertheless, the length of its range results in its facing environmental gradients, similar in kind although not in degree, to those of the coastal region. There are, of course, local effects which alter details of the gradients but the major trends are similar. I refer principally to the gradients in temperature, humidity, and light, of which more will be said later. In view of this parallelism, it is not surprising to find parallelism in structure. Morphological parallels are set forth below.

Pigmentation.—There is parallelism in some aspects of melanism. In both series there is a reduction in the extent of areas marked by melanophores. The effect is achieved, however, in different ways. In the coastal series, the content of the melanophores weakens, and the cells become more restricted

in distribution. They tend to drop out irregularly in the dorsal network, resulting in a somewhat mottled style of coloration (as in animals from San Diego County), and there is loss ventrally, on the eyelids, and reduction on the limbs and sides. In the interior series, although there is some deepening of the melanic pigmentation as one proceeds southward, there is, at the same time, reduction in melanophores through increase in size of dorsal melanophore-free spots. In *klauberi* this effect is carried also to the ventral surfaces. Further, there is comparable restriction in the distribution of melanophores on the limbs and feet.

With regard to ventral lipophore development, there is less well-defined parallelism but there is loss in the coastal series to the south, as there is in the interior races. The principal difference between them is in the place (in relation to latitude) and rate of loss. Interiorly lipophores are rapidly lost in the zone of intergradation between *oregonensis* and *platensis,* well to the north, whereas coastally, decline begins farther south and extends over a much greater area, the zone of diminution occurring between San Francisco Bay and Point Concepcion.

In both series there is southward loss of iridic and skin guanophores, but again the rate of change differs.

There is parallelism in size, the spotted races (as a unit) resembling the coastal series, south of *oregonensis* and *picta,* both groups exceeding *oregonensis* and *picta* and resembling one another in snout-vent measurement. The terminal forms, *klauberi* and *eschscholtzii,* have a greater snout measurement than *oregonensis.* A parallel in eye size, as indicated by size of eye opening, is less clear-cut. *Eschscholtzii* has the largest eyes (*picta* excepted) of the coastal races. *Platensis* of the interior series is like *oregonensis. Klauberi* exceeds *platensis* in eye size, but the difference is barely significant.

ENVIRONMENTAL CORRELATION

Environmental Gradients

The extensive north-south range of *Ensatina* encompasses marked environmental diversity. Important physical factors affecting the species are humidity, temperature, and light. *Ensatina* is highly susceptible to drying and overheating and it shuns bright light. It possesses a thin moist skin, important in respiration, a low thermal optimum (perhaps around 8° to 12° C.), and its eyes are adapted for seeing in dim light. Humidity decreases toward the south and temperature and light increase. There are naturally many local effects resulting from vegetation and features of topography such as altitude, distance from the ocean, and presence of deserts.

Along with these strictly physical gradients go biological ones directly influenced by them or by other physical factors and in turn, locally affecting the physical trends. Following plant gradients are animal associates that as enemies or competitors bear on the problem of distribution, morphology, and habits of *Ensatina.*

Adaptiveness of Characters

So far the analysis has been wholly descriptive and factual. I wish now to attempt an interpretation of the facts of distribution and structure as set forth in the body of this work. In so doing, I tread uncertain ground and admittedly enter the realm of speculation. Nevertheless, some deductions seem warranted. Several of the hypotheses that follow are being subjected to experimental study.

PIGMENTATION

In the coastal races there is a general correlation between melanism and humidity, animals from more northerly areas and higher altitudes, where precipitation is greater, having greater numbers of melanophores. Darkest individuals come from the coastal redwood belt. Although their melanophore distribution is similar to that of populations farther north in Oregon and Washington, in the Douglas fir belt, the melanophores are more intensely black, suggesting greater melanic content. The correlation is maintained, however, since the redwoods produce their own local conditions of high humidity through their dense shade, heavy leaf mat, and fern understory.

Increased melanism also correlates with reduction in light intensity, the darkest individuals appearing in the redwood belt where light is weak. A broad correspondence is present between the abundance of melanophores and the north-south temperature gradient, the animals with these cells more extensively distributed occurring in colder areas.

What are possible advantages of dark coloration where humidity is high and light intensity and temperatures are low? An explanation suggests itself for the relationship between melanism and humidity. When discovered in its natural setting, *Ensatina* is in color harmony with its background. The dorsal ground color of the coastal races tends to blend with the colors of the substratum, consisting of various shades of brown, reddish, orange, yellowish, gray, and black, colors of leaf litter, decayed wood, and soil high in organic content. Perhaps the dark color of *Ensatina* in the dimly lighted redwood stands, with their deep shadows and surface layers of rotting leaves, can be interpreted as concealing coloration. The light-colored proximal segments of the limbs, rather than making the animal conspicuous, further aid its concealment. They catch the eye and by their brilliance tend to level out the lesser contrasts between the outline of the animal and its somber background (see Cott, 1940: 52). They contradict the true form, passing as part of the scattering of light-colored objects such as splinters of less completely decayed wood and recently fallen redwood leaves. The effectiveness of the color pattern is enhanced by the behavior of the animal when exposed. It characteristically remains motionless, sometimes for several minutes.

Lightening of the animals in more southerly areas may be related to weaker development of leaf litter and less darkening of the soil with organic debris. Further, less time is spent on the surface in drier areas; hence, other things being equal, close background matching would be of less importance. Reduc-

tion of surface activity, for another reason, may be related to the gradual reduction in intensity of the melanic ground color in animals north of the redwood belt. Activity in the north is reduced when the surface becomes frozen, a phenomenon of less importance in the south. Future studies may show that *Ensatina* in the coast redwood belt and adjoining areas have the longest active period. The zone appears to be optimum in humidity, temperature, and other environmental requirements.

Ensatina spends much time underground in rodent burrows and other cavities. In the north, and at high elevations, retreat to subterranean niches probably occurs to a considerable extent in winter to avoid freezing and in the south and at lower altitudes in summer to avoid overheating and desiccation. Because of relatively constant temperature conditions at depths to which the animals can retreat and owing to their surface feeding habits, any thermal role for coloration is probably related primarily to the period of surface activity. What then is the nature of this activity?

These salamanders typically spend their time during the day under surface objects such as rocks, logs, boards, bark, and in leaf litter. Here they feed on earthworms and various surface-dwelling arthropods such as termites, camel crickets, beetles and their larvae, sowbugs, and spiders. The precise optimum temperature range for feeding and other life activities of the species and its races has not been determined. For animals in the Berkeley Hills, California, it appears to be below 18° C. and above 6° C. Probably in general above and below this range they tend to move underground or fail to emerge. In the course of a day, the temperature under a piece of thin surface litter may change considerably, even in the shaded areas commonly occupied by these animals. This change may be a continuous gradual rise and fall or there may be fluctuations superimposed on the general trend, the character of the thermal changes depending upon the thickness of the overlying cover, its exposure to the sun's rays, air currents, soil moisture conditions, time of year, and perhaps other factors. Thermal fluctuations within the general daily trend may occur through alternate shading and illumination of the cover as the mosaic of light and shade of the forest floor shifts with solar changes. Since *Ensatina,* particularly during the milder seasons of the year, is often found under thin surface objects, seemingly shunning thick insulating material, one may suppose that the animals are subject to ranges in temperature that may extend above and below their optimum—the range in which capture of food, digestion, and other activities are facilitated.

If it is true that rate of absorption of infrared is related to the degree of melanism, then the advantage of light color in areas where temperatures are relatively high and dark colors where they are low can be seen. Thus, of two individuals, one dark, the other light colored, other factors being equal, the dark one would be forced to give up surface activity in the face of rising temperatures before the light one. It would be at a disadvantage in a region where the upper thermal limit is often crowded, but would be at an advantage where lower temperatures prevail. Thus in the north or at high elevations where low temperatures are common a light-colored animal might be at a

disadvantage, since rate of warming during the general daily thermal increase as well as during the short periods of insolation of the overlying heat-transmitting cover conceivably could be important in feeding, digestion, and other life activities.

The capacity for darkening and lightening the skin through melanophore activity also may be important here. Thus the period during which the animal stays within the optimum range might be extended by acceleration of the accumulation of body heat through darkening the skin, followed by a forestalling of retreat by lightening it, thereby reflecting infrared.

Lipophore development.—The ventral lipophores form a network of varying density around the dermal capillaries. Because of the lipoid content of these cells, the blood vessels are, in effect, jacketed by a more or less continuous fatty sheath. Is it possible that this sheath interferes with the rate of water absorption through the skin? It is known that *Ensatina* obtains water in this manner (Stebbins, 1945), the urinary bladder seemingly acting as a hydrostatic organ eliminating the excess. In absorption, water probably enters the capillaries; the mucous and poison glands in the interstices of the capillary bed are secretory in function. Water loss through the skin is primarily through the mucous glands that pour their serous fluid onto its surface in connection with dermal respiration.

Coastally, in the range of *Ensatina,* water becomes scarce to the south, and in the rather arid Sierran system and mountains farther south, soil water or water in surface litter is less abundant than in northerly areas. Possibly loss of lipophores coastally and interiorly is related to their interference with absorption in areas where water is scarce.

Conversely, to the north, where the other extreme may be reached, that of an overabundance of water, energy may be conserved by passively reducing the intake by means of the fatty sheaths of the capillaries. The hydrostatic requirements placed on the bladder would thereby be minimized.

The increase in brilliance and density of the ventral lipophore network in east-Bay *Ensatina* may appear to be somewhat incongruous with this theory. I will refer to this later.

Guanism.—I can offer no explanation for trends in guanism of the skin, but possible functions can be seen for the eye patch, which may (1) act as a reflector of light, or (2) play a part in a scheme of adaptive coloration, serving either in recognition or concealment. As a reflector, it may increase the opacity of the iris.

Both functions presuppose exposure to light. To some who have collected *Ensatina,* both may seem unlikely in view of the habits of the animals. *Ensatina* is generally considered nocturnal in habit, emerging from its diurnal retreat beneath surface litter to forage at night. During the day it remains concealed, individuals rarely having been observed exposed on the surface. Considerable time is probably spent in total darkness underground during periods of temperature extremes and low humidity.

From considerable field experience with the species in California, I am of the opinion that light may be of greater importance in the life activities of

this animal than has been supposed. It appears to be important in feeding, since vision is employed. Captive individuals require moving prey to set off the feeding reaction, dead animals being ignored. In good light (daylight from a large window but not direct sunlight), an insect as small as *Drosophila* can be detected at a distance of at least four inches. Whether the sense of smell is used in finding prey is not known. If subterranean feeding occurs, this sense would seem to be required, yet the failure of captive animals to feed upon dead insects arouses doubts regarding its use. To what extent sight is employed in other activities such as detection of enemies and other individuals, is not known. Captive animals retreat upon my approach, perceiving my movements at a distance of several feet. The type of cover selected may in part be related to the use of sight in capturing prey. During the period of surface activity, *Ensatina* is commonly found beneath loosely placed objects, under which there may be considerable light.

Although most surface movements take place at night, some diurnal wandering occurs, at least in parts of the range of the species. Student reports and personal observations show that occasionally this happens in the vicinity of Berkeley in the range of *xanthoptica*. In nearly every instance, the observation was made on an overcast, cool day, during wet weather. Some of the reports are without doubt based on individuals that had been washed out by heavy rains or had escaped a predator upon being carried into the open, but there is a residue of evidence that indicates that some voluntary movement occurs.

From the foregoing, it seems possible that the guanistic iris patch may be an adjunct to opacity of the relatively thin iris of these urodeles. In support of this view what evidence is found in the structure of the eye patch, its geographic variation, and in the pigmentation of the iris of other salamanders?

That the iridic guanophores increase opacity of the iris is inferred from their manner of occurrence. These cells are always more abundant dorsally where light from the sky or reflected light from an overlying surface usually would fall. A subsidiary patch is often present in the lower iris, perhaps correlated with light reflected from the ground. Guanism is absent or weak in a zone following the long axis of the horizontally oval pupil, a region likely to receive the least amount of light. The distribution of reflective material appears to be arranged for overhead illumination. Even the weak light encountered in crepuscular activity may conceivably require reflection to facilitate the functioning of eyes designed for twilight or night vision. The arrangement of the guanophores, if their role be interpreted correctly, suggests that they may function principally when the animal is in the open, since a light differential would not be as great or would not occur beneath a surface object. A differential would exist beneath an object if its undersurface were smoother than the substratum. This is often true in situations under which one finds *Ensatina*.

Furthermore, the guanophores are superimposed on the melanic ground color of the iris. They appear to augment rather than usurp the function of the melanophores. Both cell types contribute to opacity of the iris but in dif-

ferent ways, the guanophores by reflection, the melanophores by absorption.

Variation in size of the eye patch follows the presumed variation in amount of exposure to light. The patch reaches its greatest development in east-Bay *Ensatina*. It rapidly disappears to the south and declines more slowly to the north, but does not disappear. It is almost lost in the zone of intergradation between *oregonensis* and *platensis,* then declines and finally is lost to the south, in the interior races.

In the coastal series reduction to the north and loss to the south perhaps is to be explained by decrease in the total amount of time spent on the surface annually, the southern animals being forced to retreat in summer and the northern ones in winter. Further, lower humidity and higher temperatures force the southern races to greater nocturnality. From these arguments it would seem that the eye patch should be most fully developed in the north-coast redwood belt and adjacent areas, the presumed zone of optimum conditions. It is true that in this zone it is well developed, particularly in the race *picta,* but it is surpassed by that of *xanthoptica* farther south. Perhaps the perpetual twilight of the dense redwood and Douglas fir forests has been important in somewhat reducing the survival value of a light-reflecting mechanism.

Although rainfall is less in the east-Bay area than in the redwood belt, the fogs both from the Bay to the west and from the marsh lands of the Central Valley drainage to the east temper the climate and retard drying of the ground. This effect, in conjunction with comparatively sparse vegetation, may in part explain the highly developed eye patch.

Variation in iridic guanism in the interior series fits the same line of argument. The Transition Zone of the Sierra and the mountains to the south, the zone largely occupied by the spotted races, is arid as compared with that of the coast. Farther removed from the tempering effect of the ocean, it is a zone of greater extremes, colder in winter, warmer in summer. Surface activity of *Ensatina* is probably reduced. To the south the effect is accentuated and *klauberi* may be as completely nocturnal and secretive as *eschscholtzii.* Both lack the iris patch.

The decline in the eye patch in the intergrading zone between *oregonensis* and *platensis* can be explained in a similar way. As in other zones of intergradation, temperature and humidity seem less favorable than in adjoining areas. This probably results in reduced surface activity. The Transition Zone narrows down with the relatively dry Upper Sonoran conditions of the upper Pit River drainage almost penetrating to the foothill Upper Sonoran of the northern Sacramento Valley. It is a zone of low relief (as compared with adjoining areas), far from the coast, and in the rain shadow of the Trinity and Siskiyou mountains.

It is of value in this analysis to compare the iris color of *Ensatina* with other western urodeles, at the same time taking into account their habits. I am limited in this discussion because of lack of information on variability. Most western plethodontids are similar to *Ensatina* in general habits, remaining under objects in the daytime and going underground when the surface freezes

or during dry weather. To my knowledge none is more inclined toward diurnal wandering except, perhaps, *Hydromantes.* This animal has more extensive iridic guanism than any other Californian plethodontid, as far as I am aware. This may be related to adherence to a color scheme that closely resembles the substratum of granite upon which this animal commonly occurs. Adams (1942:192) reports diurnal movements in 2 individuals of 43 observed. I know of no such records for the other genera, *Plethodon, Batrachoseps,* and *Aneides.* These genera, at least in California, all have weak guanism of the iris.

Among ambystomids, *Ambystoma gracile* and *californiense* lack or have weak development of iridic guanophores. In *Dicamptodon,* they are abundant but small and scattered, and in *Rhyacotriton* they may form a fine network, best developed in the upper iris. *Ambystoma macrodactylum* has well-developed iridic guanism, particularly of the upper iris. As regards habits, *A. gracile* and *californiense* are secretive, the latter occurring in dry areas, living in rodent burrows or other underground refuges, and resorting to transient pools for breeding. *Rhyacotriton* is more aquatic than the others, living in turbulent streams in wooded areas. *Dicamptodon* rather commonly is found foraging in the daytime. Its large size and habitat make this possible. *Ambystoma macrodactylum* is also found occasionally in the open in damp weather.

The salamandrids, genus *Triturus,* are notable among western salamanders for their diurnal habits. With the exception of *T. rivularis,* they have the best-developed iridic guanism. It is perhaps significant that the exception, *rivularis,* is more stream confined than the others and is largely restricted to the redwood zone of the north coast of California, whereas the others range over much greater areas.

This brief survey of possible correlation between iridic guanism and exposure to light reveals nothing contradictory to the hypothetical functional relationship between eye patch and amount of exposure to light presented for *Ensatina.*

In view of the wide distribution of guanism of the iris among amphibians, both larval and adult, its absence appears to be the derived condition rather than the primary one. It is pertinent here to note that young *Triturus rivularis* have considerable numbers of iridic guanophores that disappear upon metamorphosis, the transformed animals having dark eyes.

Color patterns.—I have already commented on the general color resemblance to background and the disruptive markings of the coastal races. Two topics relating to pattern remain to be discussed. The first is a possible mimetic function of the coloration of *xanthoptica* and the second is the significance of the spotted and blotched markings of the interior races.

The coloration of *xanthoptica* closely resembles that of *Triturus torosus.* The brown dorsum, orange venter, and yellow iris correspond with the coloration in this species. *Triturus* is common in areas occupied by this race and it is also found in other parts of the range of *Ensatina.* On a number of occasions I have mistaken a young *Triturus* for an *Ensatina* until skin texture and differences in proportions revealed its identity. The color correspondence is so

close that it seems probable that the resemblance of *Ensatina* to *Triturus* may have survival value for the former. An enemy of salamanders in the range of *xanthoptica* is the garter snake, *Thamnophis elegans atratus*. Fitch (1940: 96) records this animal feeding on *Ensatina* as well as *Aneides* and *Batrachoseps*. *Triturus*, an abundant salamander, of diurnal habits, a likely subject as to size and availability was not found in 59 snakes studied. Its absence would seem to be significant. Furthermore, this snake in captivity commonly shuns *Triturus* but will eat *Ensatina*. With this predator, the hypertrophied poison glands of head and tail, thought by Hubbard (1903) to function in the defense of *Ensatina*, seem to be rather ineffectual. The requisite conditions are thus present for the development of mimetic resemblance, assuming response by this garter snake to color and pattern of prospective prey.

To the south, the correspondence breaks down. The range of *T. e. atratus*, as now known, does not extend south of Point Concepcion in California, where typical *eschscholtzii* appears. Predation by garter snakes is probably unimportant throughout most of the range of this more southerly race. The habits of *Thamnophis sirtalis* preclude it as a significant enemy and *T. e. elegans* is of limited occurrence. Under present conditions of scarcity of *Triturus*, more nocturnal activity of *Ensatina*, and absence of garter snakes as predatory agents, the development of mimicry in relation to such predation would not appear to be favored.

North of *xanthoptica*, the correspondence is less marked, yet races of *Thamnophis elegans*, of terrestrial habits (*atratus*, and *elegans*), and *T. ordinoides* as well as *Triturus* occur in the range of *Ensatina*. Can diminution in degree of resemblance be related to reduced visibility in the redwood and Douglas fir forests along with the occurrence of *Triturus* species (*granulosus* and *rivularis*) that have less brilliant, reduced, or no iridic guanism?

I am unable to provide a very satisfactory explanation for the basic color difference between the coastal and interior races of *Ensatina*—one group unspotted, the other spotted. My impression in collecting the spotted races has been that the more southerly animals encounter greater contrasts in coloration of the substratum. At Fort Tejon, Crystal Creek, and in the mountains of San Diego County, the animals were found in areas where vegetation was spotty and deposits of dark leaf litter were interspersed with areas of light-colored soil. But animals in the humid coastal forest in northern California, Oregon, and Washington are generally found on a more uniform substratum. Perhaps an inherent tendency toward light-colored spotting of the body (as observed in *picta* and some *oregonensis*) or mutations producing such a pattern were selected in the interior mountain populations because of the greater versatility in background matching of the spotted pattern.

The trend in color and pattern among the spotted races is toward greater definition and contrast in markings. Assuming the pattern to be concealing in function, what survival value might there be in such a trend? I believe anyone who has collected spotted *Ensatina* will agree that the dorsal light markings, rather than rendering the animal more readily seen, distinctly delay recognition. They operate in the same manner as the light-colored seg-

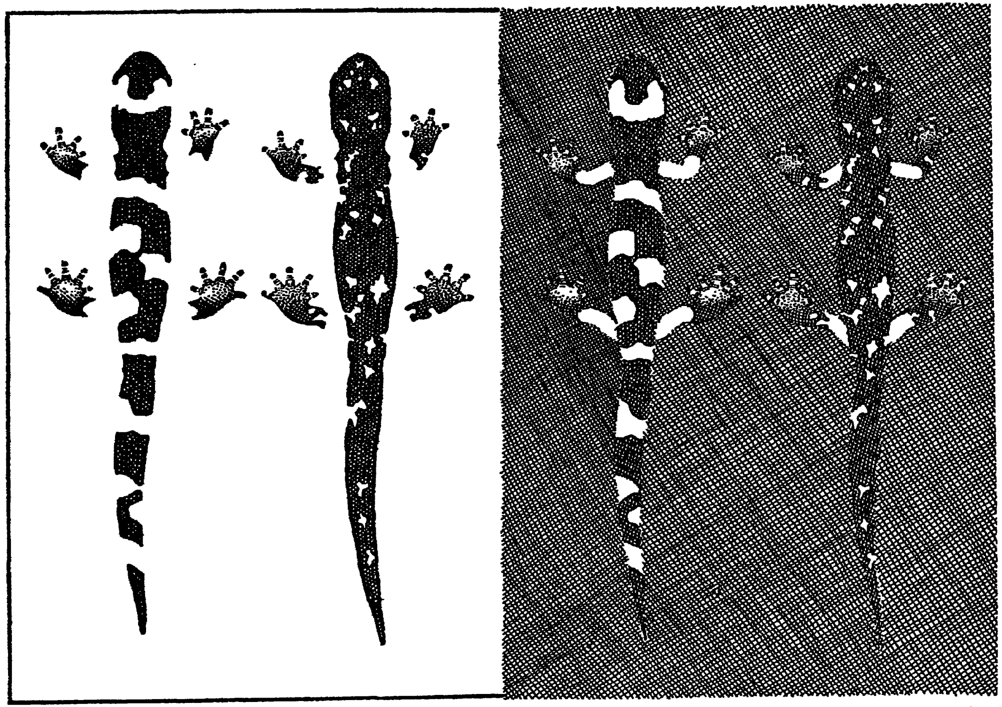


Fig. 15. Differential blending in blotched races of *Ensatina*. Greater versatility in background matching is shown by *klauberi* (on the left) as compared with *platensis*. Due to the large size of the light markings and their intersection of the outline of the body, *klauberi* is equally well concealed on a light or dark background. *Platensis*, however, is conspicuous on a light background, since its small light markings do not merge with its surroundings in such a way as to effectively break up the outline of the body. On a dark surface, however, it is as well concealed as *klauberi*.

ments of the limbs as described for the unspotted races (p. 487), catching the eye by their brightness and leveling out the lesser contrasts between the telltale outline of the animal and its background.

Two ends are achieved by increase in size of spots and contrast in pattern. Enlargement of the light markings results in greater interruption of the outline of the animal, and at the same time gives the salamander greater versatility in background matching. Animals at Crystal Creek in the San Bernardino Mountains, for example, were found on both light and dark soil. When on a light background, the light elements in the pattern blended with the predominant color of the substratum with the result that an irregular series of dark markings was presented to the eye. When on a dark background, the reverse was true. Such differential blending would not be possible for a spotted animal like *platensis*. It would appear quite conspicuous against a light-colored substratum (text fig. 15).

If it is correct that *klauberi* is more nocturnal in habit and must remain underground, in logs, or otherwise concealed for longer periods than *platensis*, under such conditions of reduced light, it may be found that greater contrast in pattern is required if its disruptive effect is to be retained.

SIZE

(Text fig. 14, p. 482)

The north-south clines of increasing size appear to be related to humidity and thermal factors. A large animal, larger at all stages of its life history, other things being equal, would be more resistant to desiccation than a small one because of the surface-mass ratio phenomenon. A large amphibian has relatively less surface in relation to mass through which to lose or gain water than a small one.

In relation to the north-south temperature gradient and fluctuations that occur beneath surface objects sought by the animals, size may also be involved. The same relationship between surface-mass ratio and heat loss and gain as has been pointed out for reptiles by Fitch (1940), Cowles (1941), and others, would seem to hold, although at a much lower temperature range. How this effect might operate may be clarified by reading the discussion of pigmentation and its possible role in thermal control (pp. 488–489), thinking in terms of the surface-mass ratio.

The dwarf race *picta* does not fit the cline in size. This race on the mainland appears as an "island" population of small size, surrounded by *oregonensis*, with a true insular population of weakly blotched animals on Whale Rock, 3 miles offshore. The surrounding populations, including that on Whale Rock average larger than the heavily dark-blotched individuals of the mainland. My experience in collecting *picta* has suggested that it may be living under wetter conditions than *Ensatina* elsewhere in California. In a salamander that respires in large part through the skin, excessive water interferes with breathing. A submerged individual will expire, even though its head remains out of water. Can small size be an adaptation to soaked soil and leaf litter? A small animal would have a greater respiratory surface in relation to its mass than a large one. The extensive lipophore development also would be expected if the hypothesis presented on page 489 is valid.

PROPORTIONS

(Text fig. 14, p. 482)

The north-south trend toward increasing size of the eye opening in both the coastal and interior series may be interpreted as relating to more nocturnal habits and to reduction in exposure to light. This measurement is presumed to reflect greater eye size, a common accompaniment of nocturnality.

The southern terminal races, *klauberi* and *eschscholtzii,* have a longer snout in the male than in more northerly races. With this there seems to be a correspondingly greater extension of the forks of the nasolabial groove along the edge of the upper lip. Until additional adult males are taken at the height of the breeding season, however, variation in this characteristic cannot be treated statistically.

FACTORS INFLUENCING CHARACTERS

In the absence of breeding experiments, little can be said about the inheritance of characters and, at the present time, the likelihood of performing successful breeding tests with this species seems remote. In the absence of experimentation on the direct effect of the environment on pigmentary characters, one cannot rule out the possibility of such effects. It has long been known that environmental factors can influence coloration without the mediation of the genetical system.

Recently, it has been shown that the lipoid coloration of wild trout can be produced in pale hatchery fish by feeding carotin (Dept. of Interior Information Service, advance release, 1946). The color so produced in fins and on the body is relatively stable, persisting 6 weeks to 2 months after the fish are taken off the diet. Can the heavy lipoid development of east-Bay *Ensatina* be due to feeding habits? Sumner (1944 and 1945) has shown that the melanin and guanin content of the skin in certain fishes can be altered by exposing the animals to backgrounds of differing albedo. Fishes on light backgrounds become light colored due to increased deposition of guanin and development of guanophores and those on dark backgrounds darken due to increased melanic content. Stimuli received through the eyes are important in bringing about these changes. To what extent such phenomena may be involved in color differences in *Ensatina* is unknown. Are *Ensatina* dark in Transition areas because of a nonheritable response to a darker visual environment than is usually found in the Upper Sonoran Zone? If these animals parallel the fishes in their chromatic responses to visual stimuli, the possibility seems unlikely, since lightening in drier, better illuminated areas is not due to increased guanin, but rather to a weakening of the melanic content of the skin. Furthermore, guanin may increase in populations where melanism is great. The uniformity in pigmentation of recently hatched young, independent of local conditions of humidity, temperature, and light, and the similarity between young and adults make it appear unlikely that the chromatic characteristics discussed in this paper are the results of such direct environmental influences.

TABLE 20

MEASUREMENTS AND COUNTS OF TEETH OF SUBSPECIES OF ENSATINA ESCHSCHOLTZII
(All animals used in this analysis are adult males unless otherwise indicated)

Measurements and counts	*platensis*	*klauberi*	*oregonensis*	*picta*	*xanthoptica*	*eschscholtzii*	
						Males	Females
Snout–vent							
Number	13	10	20	21	16	14	16
Maximum	70.1	69.0	58.3	56.4	69.2	71.5	71.2
Minimum	59.3	56.3	48.2	40.2	51.0	54.2	56.2
Range	10.8	12.7	10.1	16.2	18.2	17.3	15.0
Mean	64.3±.96	61.66±1.27	53.0±.49	48.4±.80	59.9±1.34	63.3±1.84	64.1±1.11
Standard deviation	3.45	4.03	2.21	3.66	5.50	6.87	4.43
Tail							
Number	10	9	15	20	13	13	14
Maximum	108.7	105.83	106.9	109.8	111.1	108.6	93.2
Minimum	80.3	76.38	86.8	73.9	91.2	77.8	62.7
Range	28.4	29.45	20.1	35.9	19.9	30.8	30.5
Mean	97.7±2.58	92.89±3.35	95.6±1.29	97.3±1.87	102.2±1.84	94.1±2.56	77.7±2.18
Standard deviation	8.17	10.06	4.98	8.56	6.63	9.23	8.17
Head and neck							
Number	13	10	20	21	16	14	16
Maximum	36.14	35.36	36.6	38.3	38.1	39.5	35.7
Minimum	30.58	31.59	31.3	31.5	32.6	31.5	31.3
Range	5.56	3.77	5.3	6.8	5.5	8.0	4.4
Mean	33.76±.45	33.63±.40	33.5±.30	34.2±.44	34.5±.40	34.1±.56	33.1±.28
Standard deviation	1.61	1.28	1.36	2.01	1.60	2.11	1.11
Snout to gular fold							
Number	12	10	20	21	16	14	
Maximum	29.81	29.13	28.3	30.3	29.9	31.1	
Minimum	25.59	26.67	26.1	25.9	25.9	26.5	
Range	4.22	2.46	2.2	4.4	4.0	4.6	
Mean	27.53±.35	28.05±.23	27.07±.05	28.2±.24	28.3±.26	28.0±.33	
Standard deviation	1.22	.72	.21	1.1	1.02	1.24	

TABLE 20-A

Measurements and Counts of Teeth of Adult Male Representatives of Subspecies of Ensatina eschscholtzii

Measurements and counts	platensis	klauberi	oregonensis	picta	xanthoptica	eschscholtzii	
						Males	Females
Axilla to groin							
Number	13	10	20	21	16	14	16
Maximum	48.18	49.86	49.4	49.5	50.0	58.3	52.8
Minimum	43.43	43.61	42.2	43.9	39.5	45.6	45.2
Range	4.70	6.25	7.2	5.6	10.5	12.7	7.6
Mean	46.27±.37	46.72±.68	46.3±.42	46.5±.33	46.2±.65	48.3±.86	48.2±.59
Standard deviation	1.34	2.15	1.87	1.53	2.59	3.21	2.36
Fore-limb length							
Number	13	10	20	21	16	13	16
Maximum	33.67	34.09	33.1	34.1	35.6	33.4	33.1
Minimum	28.99	28.70	28.5	29.6	29.9	30.7	29.7
Range	4.68	5.39	4.6	4.5	5.7	2.7	3.4
Mean	31.35±.38	31.95±.50	31.3±.27	31.8±.31	32.1±.34	32.2±.22	31.5±.26
Standard deviation	1.39	1.59	1.19	1.42	1.36	.78	1.02
Hind-limb length							
Number	13	10	20	21	16	14	16
Maximum	37.46	37.70	35.5	37.3	38.9	40.4	36.5
Minimum	32.17	30.58	30.9	31.3	32.0	32.1	31.5
Range	5.29	7.12	4.6	6.0	6.9	8.3	5.0
Mean	34.66±.40	34.73±.61	33.9±.30	34.3±.35	34.8±.43	35.1±.57	33.7±.35
Standard deviation	1.44	1.93	1.33	1.61	1.70	2.15	1.39
Anterior eye corner to eye corner							
Number	12	10	20	21	16	14	16
Maximum	9.75	9.69	10.37	10.22	9.77	9.33	8.99
Minimum	8.45	7.84	8.58	8.27	8.47	7.19	7.46
Range	1.30	1.85	1.79	1.95	1.30	2.14	1.53
Mean	9.11±.04	8.95±.17	9.29±.03	9.15±.10	8.96±.09	8.52±.16	8.20±.11
Standard deviation	.14	.54	.15	.49	.35	.61	.44

TABLE 20-B

MEASUREMENTS AND COUNTS OF TEETH OF ENSATINA ESCHSCHOLTZII

Measurements and counts	*platensis*	*klauberi*	*oregonensis*	*picta*	*xanthoptica*	*eschscholtzii*	
						Males	Females
Anterior eye corner to anterior edge of nostril							
Number	12	10	20	21	16	14	16
Maximum	6.83	7.40	6.51	7.21	7.06	7.46	6.65
Minimum	5.91	5.76	5.68	5.51	5.88	5.62	5.57
Range	.92	1.64	.83	1.70	1.18	1.84	1.08
Mean	6.35±.09	6.56±.16	6.16±.06	6.39±.11	6.44±.07	6.46±.14	6.08±.08
Standard deviation	.31	.50	.25	.51	.30	.53	.33
Eye opening							
Number	12	10	20	21	16	14	16
Maximum	6.50	6.89	7.14	7.69	7.59	7.81	7.47
Minimum	5.67	6.09	5.63	6.58	5.61	6.02	6.25
Range	.83	.80	1.51	1.11	1.98	1.79	1.22
Mean	6.26±.06	6.58±.08	6.42±.09	7.06±.07	6.44±.12	6.73±.15	6.70±.07
Standard deviation	.22	.27	.43	.31	.46	.55	.29
Vomerine teeth							
Number	12	10	17	20	16	14	16
Maximum	24	26	32	25	27	26	30
Minimum	18	20	17	13	12	18	20
Range	6	6	15	12	15	8	10
Mean	21	23	21	18	20	22	24
Parasphenoid teeth							
Number	5	..	4	6	7	8	11
Maximum	120	..	117	82	66	81	98
Minimum	75	..	57	65	50	47	60
Range	45	..	60	17	6	44	38
Mean	96	..	86	71	63	73	79

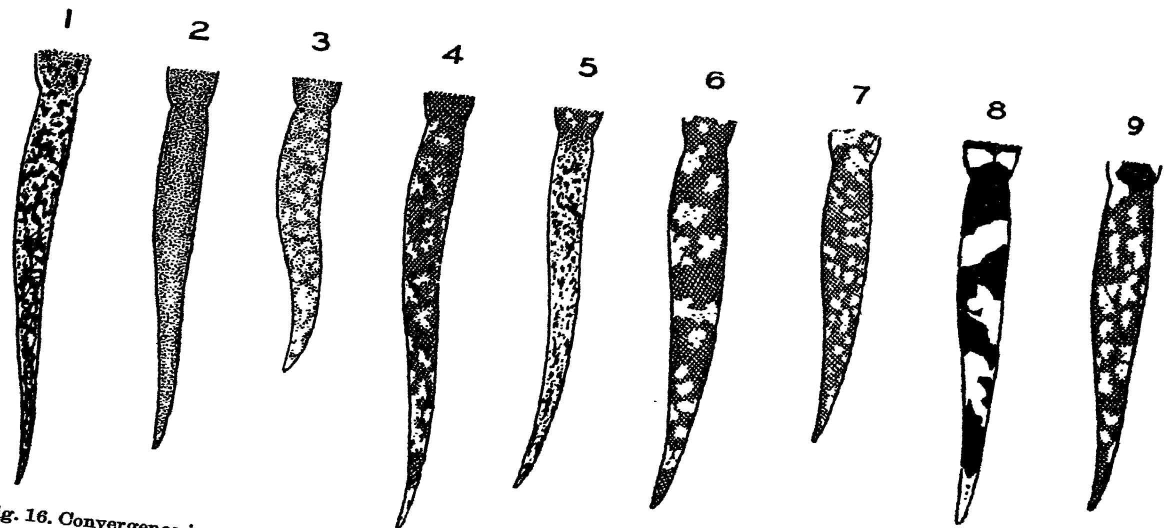


Fig. 16. Convergence in markings of regenerated tails in subspecies of *Ensatina eschscholtzii* and their resemblance to the normal tail pattern of the race *picta*. Typical tail pattern of *picta*—1; *oregonensis-xanthoptica* intergrade—2, original and 3, regenerated; *oregonensis-platensis* intergrade—4, original and 5, regenerated; *platensis*—6, original and 7, regenerated; *klauberi*—8, original and 9, regenerated.

Specimens upon which drawings were based are as follows (All are from California): (1) CAS 81149, ♂, Mill Creek, Del Norte Co.; (2) MVZ 4945, ♀, Freestone, and (3) MVZ 12551, ♀, Bohemian Grove, Sonoma Co.; (4) MVZ 42165, ♂, 3.4 mi. E and (5) MVZ 42161, ♂, 19.3 mi. E Court St. in Weaverville on U. S. 299, Trinity Co.; (6) SNHM 6507, ♀, Strawberry, Sonora Pass, Tuolumne Co.; (7) MVZ 42700, ♀, 15 mi. N Downieville, Sierra Co.; (8) LMK 24027, ♂, Cuyamaca, San Diego Co.; (9) SSNH 17566, ♀, Lower Doane Valley, Palomar Mt., San Diego Co.

Differing bodily proportions in the several races conceivably could be a function of size attained, as Simpson (1944) discusses in his survey of skeletal proportions in fossil horses. But this also seems rather unlikely in *Ensatina* because the largest races have the largest eyes, which would involve a reversal of growth trends, since young animals have larger eyes in proportion to body length than adults. The growth trend in each race is toward reduction in eye size with increase in body length.

ORIGIN OF THE SPECIES AND SUBSPECIFIC DIFFERENTIATION

Ancestry and Center of Origin

The center of origin of the genus *Ensatina* probably was somewhere in northwestern North America, perhaps, although not necessarily, in the present area of greatest abundance in the redwood and adjoining Douglas fir belts in northern California and southwestern Oregon. The animals considered most generalized occur in the north with races to the south showing specializations in coloration and form.

The race *picta* may be close to the ancestral type, if not actually the ancestral *Ensatina.* It is the most generalized of all the races having characters that embrace most of the variations of the other forms. Nothing basically new is added by any other race. Changes have to do with loss of characters or rearrangement of basic materials. Thus there is loss of guanophores, lipophores, and melanophores to the south in varying amounts and at different rates. There is rearrangement of the melanophores of the mottled pattern as one proceeds from the zone of *picta,* resulting in a more even dispersion coastally, and a more definite segregation to form melanophore-free spots and blotches interiorly.

In further support of *picta* or a *picta*-like form as ancestral, is the occurrence of mottled young in *oregonensis* and the *picta*-like distribution of guanophores in young *oregonensis-platensis* intergrades and juvenal *platensis.*

Tail regeneration also seems to point toward an ancestral type with mottled pattern, if such secondary pigmentation can be relied upon as reflecting an ancestral condition. Figure 16 shows the similarity in the regenerated tails of some of the races and their resemblance to the normal tail of *picta.* It should be pointed out, however, that not all regenerated tails are mottled, but neither are all original *picta* tails well marked.

In its large eyes, small size, and pattern, *picta* exhibits juvenal characteristics. Its restricted range and occurrence in a zone of optimum conditions in the humid and thermally mild redwood belt, is what one might expect of an ancestral form, faced with a climatic trend toward increasing aridity.

Dispersal and Differentiation

In the absence of fossils, it is impossible to reconstruct the past distribution of the genus. Some inferences, however, can be made on the basis of present distribution, morphology of the races, and the geological history of California. Assuming a northern origin, it appears likely that there was southward

movement, during periods of greater humidity than now, along the interior and coastal mountain ranges in California. These advancing fingers of dispersal were kept separated by the Great Valley, whose history would seem to preclude, until comparatively recently, the possibility of a juncture between them. The valley long must have been a barrier to plethodontids. It has been occupied by the sea, the regression of which must have been followed by a salt water marsh stage, which, with drying, permitted the development of present conditions—a low, relatively hot, dry area with little natural vegetation other than grass.

The north-south mountain ranges meet in southern California, the interior mountains curving westward to join the Coast Range, thereby delimiting the southern end of the San Joaquin Valley. This topographic characteristic provided for a juncture between the two lines of dispersal, but at a point 450 miles south of their northern area of bifurcation.

During the period of isolation of the coastal and interior populations, differentiation proceeded far enough to prevent interbreeding when they finally entered the mountains of southern California. What isolating mechanisms were developed has not been determined. Overlap in distribution there precludes ecological segregation of a zonal type.

Apparently during Pleistocene time or at some other comparatively recent period, geologically speaking, the region of the Great Valley became habitable. This permitted the coastal stock *xanthoptica*, less restricted in zonal requirements, to disperse across this valley at its most humid part—opposite San Francisco Bay, where the valley narrows and the San Joaquin and Sacramento drainages come together. Upon reaching the Sierran foothills, an extensive new area became available to this form which dispersed upward into the zone occupied by *platensis* (or its predecessor). This zone of contact between the coastal and interior series of subspecies, occurring relatively close to their connection in northern California, was between less divergent types than their representatives in southern California. Current study of the zone of juncture between these races indicates that hybridization of low frequency is occurring.

Thus there seems to have been progressive divergence of the interior and coastal types from an area in the north where gene flow is probably near unity and where a broad area of intergradation of a gradual type exists, through a section intermediate in distance to the south, where hybridization occurs, to a zone at the extreme south where sympatry exists with apparently complete reproductive isolation.

With trends toward increasing aridity, possibly largely effective since the Pleistocene, semi-isolation of populations in the chain of races has occurred. The effects of drying and higher temperatures are most pronounced in areas of low relief. Zones of intergradation coincide with such areas. These areas are as follows: the Salinas Valley, a strip of Lower Sonoran conditions occurring in the zone of intergradation between *eschscholtzii* and *xanthoptica;* the Ukiah Valley between *xanthoptica* and *oregonensis;* the Pit River drainage between *oregonensis* and *platensis;* the Kern River drainage between

platensis and *croceator;* and a series of low dry areas, Mint and Soledad canyons, and Cajon and San Gorgonio passes, between *croceator* and *klauberi.* Breeding must have been reduced in these regions, resulting in a decline in the rate of gene flow. Populations partly separated tended to go their own evolutionary way. I can find no basis, either in the variability of characters in these regions or in the presumed geologic and climatic history of the areas, for thinking that any of these zones of intergradation are the result of secondary junction between formerly isolated populations.

Pronounced in *Ensatina* is a tendency toward gradual change over areas of considerable size, in some instances larger than those in which there is uniformity. This has forced me to treat extensive regions as zones of intergradation. Thus intergrading areas between *xanthoptica* and adjoining races, *oregonensis* and *eschscholtzii,* are shown as greater than the area occupied by this race. The situation may be thought of as a series of plateaus and valleys for characters in which they maintain considerable constancy, separated by long slopes or clines in which most of them change gradually. The phenomenon may be due to the rate of change in environmental gradients and accompanying selection intensities.

I have attempted to relate the distribution of the races and the occurrence of intergrading zones with petrological and vegetational changes. In view of the capacity for dermal water absorption in these animals, the chemical content of the soil and leaf litter may be important. Regarding petrology, one feature of particular interest emerges. There is rather close correspondence between the occurrence of serpentine, an ultra basic intrusive, and certain areas of intergradation. This rock occurs in considerable quantity in zones surrounding *xanthoptica,* but it is not found in appreciable amounts within the range of this race except for a small deposit at its eastern limit. The correspondence between the beginning of intergradation north and west of *xanthoptica* and the appearance of this rock is almost perfect. Dr. H. L. Mason tells me that there is great variety in this area (in northern Napa and Lake counties) in the plant types. Since moisture conditions are relatively uniform, he relates this to the type of soil. Since some plants die when given water with basic mineral content derived from serpentine, it conceivably may have an effect on a water-absorbing amphibian. At least, if it affects the vegetation, it would indirectly influence the related animal population.

Serpentine appears also in the zone of intergradation between *oregonensis* and *platensis*. Here also according to Mason, is an area of variability in plant types, but it is less pronounced than the preceding example.

Other zones of intergradation coincide with plant variability, but serpentine has not been recorded. In these areas, the Walker Pass, Mint Canyon, and Cajon Pass regions, humidity and temperature factors are probably in large part responsible.

Although from considerable field experience with *Ensatina* I have come to associate certain plants or plant groups with the occurrence of the animals, I have not found a direct plant-animal relationship. The interior spotted races usually have been found in stands of incense cedar or under canyon live oaks,

but they have also appeared, less commonly beneath black oaks, yellow pines, and even interior live oaks. The plants are indicative of favorable conditions of temperature and humidity, some tending to promote and maintain such conditions more than others. In time it may be shown that certain plants are avoided or selected because of the physical and chemical properties of the leaf litter and soil which they produce. This may influence the salamanders directly or indirectly by effects on important animal associates.

The areas occupied by the races, races recognized on the basis of geographic stability of characters, are zones in which rather uniform environmental conditions prevail. Thus the Pacific northwest is occupied by *oregonensis* which follows closely the Pacific Douglas fir zone; *platensis* ranges in the Sierran block, an area of general environmental uniformity. The extent of the subspecies range correlates with the extent of the area of rather uniform conditions.

Evidence for the coexistence of the races eschscholtzii *and* klauberi.—Although the extremes of the chain of subspecies, *eschscholtzii* of the coastal races and *croceator* and *klauberi* of the interior series, have not been found in precisely the same place, there is likelihood that they so occur. Individuals are not readily found and until recently, little intensive search was made. The total number of animals in collections is not great, the counts running approximately as follows: *croceator* 15, *klauberi* 48, and *eschscholtzii* 202.

Zonal overlap exists and details regarding capture of individuals of both groups indicate that there is marked similarity in ecological niches and geographic overlap in ranges.

In Mill Canyon above Banning in the San Bernardino Mountains, San Bernardino County, I have collected *eschscholtzii* in the Transition Life-zone, at Forest Home, elevation 5,200 feet. The vegetation at the collection site was canyon live oak, black oak, incense cedar, and yellow pine. A blotched *Ensatina* (USNM specimen), probably from this canyon (see p. 463), was collected at 5,500 feet. In view of the common occurrence of this form in Transition areas, it probably was found in the same habitat as the example of *eschscholtzii*. The alternative would be that it was found in an Upper Sonoran area. This zone interdigitates with the Transition Life-zone in Mill Canyon. Another blotched individual (USNM) is known from Water Canyon, probably also in the same range (see p. 463). I found *eschscholtzii* in the Transition Zone in a canyon by this name at 6,000 feet. At Crystal Creek, on the north side of the San Bernardinos, blotched *Ensatina* occur beneath incense cedars and canyon live oaks, at elevations ranging from 5,700 to 6,200 feet. *Eschscholtzii* at Lake Arrowhead in similar vegetation has been found at 5,374 feet and in the San Gabriel Mountains, Los Angeles County, at 6,500 feet. No blotched *Ensatina* has so far appeared in this range but its occurrence is expected.

Klauberi has been taken at Descanso and Alpine in San Diego County. If these localities can be relied upon, and Dr. Klauber tells me he has no reason to doubt them, this puts the race in the Upper Sonoran Zone. At both localities chaparral is present with coast live oak in canyon bottoms and on shaded slopes. I collected an *eschscholtzii* in Harbison Canyon, 10 miles south of

Overlap between the spotted and unicolored forms will probably be increasingly evident along the juncture between the Transition and Upper Sonoran life-zones with more collecting. Apparently one type or the other dominates an area. Thus, although *eschscholtzii* is widespread in the Transition of the San Gabriel Mountains, it is not yet known from this zone in San Diego and Riverside counties where *klauberi* is present.

The occurrence of *eschscholtzii* in Transition areas may represent an expansion of the range of this race into regions vacated by the spotted form. The latter seems to have suffered greater disjunction of range and decline in numbers than the former. I view *eschscholtzii* as the more adaptable, possibly expanding, type and the blotched stock in southern California as an older group, largely committed to a montane existence by its Sierran dispersal route, and clinging to shrinking pockets of optimum conditions.

CONCLUSION

The genus *Ensatina* is a rassenkreis that illustrates well the phenomenon of species formation preceded by the process of subspecific differentiation. One viewing the two sharply contrasting types of *Ensatina* in southern California—one uniformly reddish brown, the other contrastingly marked with orange and black—without knowledge of the distribution of the genus, would certainly consider them as distinct species. Indeed, so they have long been treated. The occurrence of the animals in similar habitats and in effect in the same localities would strengthen such a position. No intermediate or hybrid animals between these two types have been found in the areas of junction.

Actually, however, they are the terminal differentiates of an intergrading series whose ends have been brought together, guided by peculiarities in the physiography of California and the environmental requirements of the animals. The chain of races is thus arranged in the form of an elongate oval, conforming to the mountainous areas of the state. The ring apparently has long been kept open in the center by unsuitable conditions in the area now occupied by the Great Valley. Weak links in the chain, areas of intergradation, coincide with regions of low relief and, in these zones, varying degrees of continuity of populations are present. One link in the series is weakly connected to the others, the race *klauberi*, being tied morphologically to *croceator* by a remnant of what was probably at one time a widely distributed interbreeding population. In the absence of this remnant, one might consider giving *klauberi* specific rank.

Thus we have happened upon a species at a stage in its evolution in which it is breaking into discontinuous populations, one form seemingly having already been severed geographically from the others, with the remainder of the series of forms tied in varying degrees of security. If present trends toward increasing aridity continue, one could rather safely predict complete geographic isolation for several of the closely related southern populations with breeding incompatibility ultimately appearing if not already present. Moreover the terminal races of the chain, which come together geographically, already appear to be incompatible and to have attained the species level in their relations to each other. That they are not actually so regarded is due to their circuitous connection through intergrading forms.

A coastal race, *xanthoptica,* presumably comparatively recently, has dispersed across the Great Valley in the area opposite San Francisco Bay to make secondary contact in the Sierra Nevada with *platensis* of the interior series. Some hybridization apparently occurs between these forms. Thus progressive genetical divergence with progressively increasing reproductive incompatibility is observed from north to south between the coastal and interior series of races—from free interbreeding in northern California, through occasional hybridization in the Sierra in central California, to sympatry with reproductive isolation in southern California.

SUMMARY

1. The genus *Ensatina* as now know is shown to be monotypic. The four species currently recognized—*eschscholtzii, sierrae, croceator,* and *platensis* all belong to one species, *eschscholtzii,* of which the following races are recognized: *eschscholtzii, xanthoptica, oregonensis, picta, platensis, croceator,* and *klauberi.* The Plata *Ensatina* of South America, *E. platensis,* is believed to be established on a specimen from the Sierra Nevada of California.

2. The range of the genus is confined to western North America, where it extends coastally from southwestern British Columbia to southern California. In California, the animals occur in the Sierra Nevada and in the interior mountains of southern California as well. In this state the races are arranged in a ring of allopatric subspecies, the circle kept open centrally by the low, dry Great Valley. The ring is continuous in northern California; the terminal forms of the coastal and interior series of races, *eschscholtzii* and *klauberi,* are strikingly differentiated salamanders and meet but apparently do not interbreed in the mountains of southern California.

3. Subspecies differ most noticeably in coloration. Those of the coast, with the exception of the race *picta,* are uniformly dark brown to reddish brown above. *Picta* is dark blotched. Those of the interior mountains in California are spotted or blotched with orange or yellow on a dark brown to blackish ground color. All races possess varying amounts of yellow to orange color on the proximal segments of the limbs. The coastal races, *eschscholtzii, xanthoptica,* and *oregonensis* differ principally in the number and distribution of melanophores, lipophores, and guanophores. The general trend, to the north, is toward darkening of melanic pigment and increase in areas possessing melanophores. Lipophore development, or the occurrence of orange or yellowish pigment, reaches its greatest development in the centrally situated race *xanthoptica,* declining rapidly, particularly on the ventral surfaces, south of the range of *xanthoptica.* The northern race *oregonensis* usually exhibits ventrally a broken lipophore network or ventral lipophores may be absent at the northern extremity of its range. Changes in guanophores are notable in the iris and skin. Those of the iris form a patch above the pupil, grading from a moderately developed rust-colored eyepatch in *oregonensis* to a conspicuous yellow one in *xanthoptica* with rapid loss to the south, *eschscholtzii* having dark brown eyes. Guanophores of the skin are most abundant to the north with gradual loss to the south.

The interior races *platensis, croceator,* and *klauberi* show relatively uniform melanophore development although there is some reduction in melanism of the limbs and deepening of the melanic ground color to the south.

Lipophores are absent ventrally on the body but are largely responsible for the color of the dorsal blotches. These are orange in *platensis,* yellow or cream in *croceator,* and orange again in *klauberi.* There is increase in size of the blotches to the south, *klauberi* having the largest markings. Guanism of the iris is weak in *platensis,* declines to the south, and appears to be absent in *klauberi.* There is similar loss of skin guanophores.

There is marked variation in size within the species. The race *picta* is the smallest, about two-thirds the size of the largest race. Aside from *picta*, the trend is toward increasing size to the south. The interior light-blotched subspecies are more uniform in size than those of the coast.

There are differences in proportions as based on study of adult males. *Oregonensis* has the smallest eyes with increase in size occurring to the south. The interior series of races show a less marked cline. Snout length follows the change in the size of the eyes, the southern races *eschscholtzii* and *klauberi*, the terminal differentiates of the allopatric series of subspecies, having the longest snouts.

4. It is suggested that variation in melanism in the coastal races may be related to thermoregulation and background matching, in lipophore development to the rate of water absorption, in guanophore development of the iris to protection of the eyes through light reflection, in spotting in the interior races to versatility in background matching, in size to dehydration and thermoregulation, and in eye size to secretiveness and degree of nocturnality.

5. *Picta* or a *picta*-like ancestor is viewed as the prototype of the species from which both the uniformly colored and light-blotched races may have been derived.

6. The center of origin of the species is thought to have been somewhere in the Pacific northwest, possibly in the area of the north coast redwood or Douglas fir forests, the present region of greatest abundance of individuals. Dispersal is believed to have been toward the south along the interior and coastal mountains of California, the terminal forms meeting in southern California. The coastal race *xanthoptica*, presumably rather recently, dispersed across the Great Valley of California, passing across what probably had long been a barrier, to make connection with the Sierran race, *platensis*. Some hybridization apparently occurs between them.

7. Increasing genetical divergence is inferred from the progressive morphological divergence between the coastal and interior series of races to the south of their juncture in northern California where the mountain systems that they inhabit are connected. In this area they are united by an extensive, smoothly intergrading population. This southward divergence is further borne out by the behavior of sympatric populations to the south. From a zone of free interbreeding in the area of intergradation, one passes to a region where partial reproductive isolation seems to exist (Sierran populations of *xanthoptica* and *platensis*), to complete isolation commonly found at the species level as appears to exist between *eschscholtzii* and *klauberi* of southern California.

LITERATURE CITED

BERG, C.

1897. Batracios Argentinos. Enumeración sistemática, sinonímica y bibliográfica de los Batracios de la República Argentina (Con un cuadro sinóptico de clasificación). Anales Mus. Nac. Buenos Aires, 5: 147–222.

BISHOP, S. C.

1943. Handbook of salamanders (Ithaca, N.Y.: Comstock Publishing Co., Inc.), xiv + 555 pp.

BOGERT, C. M.

1930. An annotated list of the amphibians and reptiles of Los Angeles County, California. Bull. So. Calif. Acad. Sci., 29(1): 1–14.

BOULENGER, G. A.

1882. Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collection of the British Museum (ed. 2; London, printed by order of the trustees), viii + 127 pp.

1892. The poisonous secretion of batrachians. Nat. Sci., 1: 185–189.

CARL, G., and I. McT. COWAN.

1945. Notes on the salamanders of British Columbia. Copeia, 1: 43–44.

CHANEY, R. W., C. CONDIT, and D. I. AXELROD.

1944. Pliocene floras of California and Oregon. Carnegie Institutiou of Washington, Washington, D.C., 553, vii + 407 pp.

COPE, E. D.

1867. A review of the species of the Amblystomidae. Proc. Acad. Nat. Sci. Phila., 1867: 166–211.

1869. A review of the species of the Plethodontidae and Desmognathidae. *Ibid.*, 1869: 93–118.

1883. Notes on the geographical distribution of Batrachia and Reptilia in western North America. *Ibid.*, 1883: 10–35.

1889. The Batrachia of North America. Bull. U. S. Nat. Mus., 32: 1–525.

COTT, H. B.

1940. Adaptive coloration in animals (New York: Oxford University Press), xxxii + 508 pp.

COWLES, R. B.

1941. Observations on the winter activities of desert reptiles. Ecology, 22(2): 125–140.

DICE, L. R., and H. J. LERAAS.

1936. A graphic method for comparing several sets of measurements. Contrib. Lab. Vert. Gen. Univ. Mich., 3: 1–3.

DUNN, E. R.

1918. The collection of Amphibia Caudata of the Museum of Comparative Zoölogy. Bull. Mus. Comp. Zoöl. (Harvard College), 62: 445–471.

1923*a*. Mutanda herpetologica. Proc. New England Zoöl. Club, 8: 39–40.

1923*b*. The geographical distribution of amphibians. Amer. Nat., 57: 129–136.

1926. The salamanders of the family Plethodontidae (Northampton, Mass.: Smith College Anniversary Series), xii + 441 pp.

1929. A new salamander from southern California. Proc. U. S. Nat. Mus., 74(25): 1–3.

1940. The races of *Ambystoma tigrinum*. Copeia, 3: 154–162.

ESCHSCHOLTZ, F.

1829–33. Zoölogischer Atlas, enhalten Abbildungen und Beschreibungen neuer Thierarten, während des Flottcapitains von Kotzebue zweiter Reise um die Welt, auf der Russisch-Kaiserlichen Kriegsschlupp Predpriaetië in den Jahren 1823–1826 (Berlin, G. Reimer), 5 parts, part 5, 1833 (edited and partly written by Martin Heinrich Rathke), viii + 28 pp.

ESTERLY, C. O.
1904. The structure and regeneration of the poison glands of *Plethodon*. Univ. Calif. Publ. Zoöl., 1: 227–268.

FITCH, H. S.
1938. A systematic account of the alligator lizards (*Gerrhonotus*) in the western United States and Lower California. Amer. Midl. Nat., 20 (2): 381–424.
1940. A biogeographical study of the ordinoides artenkreis of garter snakes (genus *Thamnophis*). Univ. Calif. Publ. Zoöl., 44 (1): 1–150.

FOWLER, H. W., and E. R. DUNN.
1917. Notes on salamanders. Proc. Acad. Nat. Sci. Phila., 1917: 7–28.

FREIBERG, M. A.
1942. Enumeración sistemática y distribución geográfica de los batracios Argentinos. Physis, 19: 219–240.

GIRARD, C.
1856. On a new genus and species of Urodela, from the collections of the U. S. Expl. Exped., under Comm. Charles Wilkes, U.S.N. Proc. Acad. Nat. Sci. Phila., 8: 140–141.

GORDON, K.
1939. The Amphibia and Reptilia of Oregon. Oregon State Monographs (studies in zoölogy), 1: 1–82.

GRAY, J. E.
1850. Catalogue of the specimens of amphibia in the collection of the British Museum. Pt. II. Batrachia Gradientia, etc. (London, printed by order of trustees), 72 pp.

GRINNELL, J., and C. L. CAMP.
1917. A distributional list of the amphibians and reptiles of California. Univ. Calif. Publ. Zoöl., 17 (10): 127–208.

HALLOWELL, E.
1856. Notes on the reptiles in the collection of the Academy of Natural Sciences of Philad'a. Proc. Acad. Nat. Sci. Phila., 8: 221–238.

HILTON, W. A.
1945. *Aneides lugubris lugubris* from Catalina Island, California. Bull. So. Calif. Acad. Sci., 44 (2): 54–56.

HUBBARD, M. E.
1903. Correlated protective devices in some California salamanders. Univ. Calif. Publ. Zoöl., 1: 157–170.

HUXLEY, J. S.
1942. Evolution, the modern synthesis (New York and London: Harper and Brothers), 645 pp.

JIMÉNEZ DE LA ESPADA, M.
1875*a*. *Urotropis platensis*. Anales Soc. Española de Hist. Nat., 4: 69–73.

KLAUBER, L. M.
1927. Notes on the salamanders of San Diego County, California. Bull. Zoöl. Soc. San Diego, 3: 1–4.

LOCKINGTON, W. N.
1880. List of Californian reptiles and batrachia collected by Mr. Dunn and Mr. W. J. Fisher in 1876. Amer. Nat., 14: 295–296.

MILLER, L. H.
1944. Notes on the eggs and larvae of *Aneides lugubris*. Copeia, 4: 224–230.

MYERS, G. S.
1930. Notes on some amphibians in western North America. Proc. Biol. Soc. Wash., 43: 55–64.

Myers, G. S., and Antenor Leitão de Carvalho.
1945. Notes on some new or little-known Brazilian amphibians, with an examination of the history of the Plata salamander, *Ensatina platensis*. Ministério da educação e saúde, Boletim do Museu Nacional, Nova Série, Rio de Janeiro, Brasil, Zoologia, 35: 1–39.

Myers, Robert B.
1939. Morphological variations in *Ambystoma tigrinum* Green at various altitudes. Univ. Colo. Studies, 26(2): 98.

Noble, G. K.
1927. The plethodontid salamanders; some aspects of their evolution. Amer. Mus. Novitates, 249: 1–26.

Parker, G. H.
1948. Animal colour changes and their neurohumours, a survey of investigations, 1910–1943 (Cambridge [Eng.] University Press), x + 377 pp.

Pequegnat, W. E.
1945. A report on the biota of the Santa Ana Mountains. Jour. Ent. and Zoöl., 37(1): 1–7.

Ridgway, R.
1912. Color standards and color nomenclature (Washington, D.C., published by the author), iv + 44 pp., pls. I–LIII.

Rüthling, P.
1915. Los Angeles salamanders. Copeia, 25: 61–62.

Simpson, G. G.
1944. Tempo and mode in evolution (New York: Columbia University Press), xviii + 237 pp.

Slevin, J.
1928. The amphibians of western North America. Occas. Papers Calif. Acad. Sci., 16: 1–152.
1930. Further notes on the genus *Ensatina* in California. Copeia, 3: 77–78.

Smith, G. M.
1933. The nasal region and organ of Jacobson of some American salamanders. Doctoral thesis, Univ. Calif. Biol. Library, Berkeley, Calif.

Stebbins, R. C.
1945. Water absorption in a terrestrial salamander. Copeia, 1: 25–28.

Storer, T. I.
1925. A synopsis of the Amphibia of California. Univ. Calif. Publ. Zoöl., 27: 1–342.
1929. Notes on the genus *Ensatina* in California, with description of a new species from the Sierra Nevada. Univ. Calif. Publ. Zoöl., 30(16): 443–452.

Strauch, A.
1870. Revision der Salamandriden-Gattungen nebst Beschreibung einiger neuen oder weniger bekannten Arten dieser Familie. Mémoires de l'Acad. Imp. Sci. St.-Pétersbourg, ser. 7, 16: 1–109.

Sumner, F. B.
1943. A further report upon the effects of the visual environment on the melanin content of fishes. Biol. Bull., 84(2): 195–205.
1944. Vision and guanine production in fishes. Proc. Nat. Acad. Sci., 30(10): 285–294.
1945. The cause must have had eyes. Scientific Monthly, 60: 181–186.

Twitty, V. C.
1942. The species of Californian *Triturus*. Copeia, 2: 65–76.

VAN DENBURGH, J.

1898. Herpetological notes. Proc. Amer. Philos. Soc., 37(157): 139–141.

1916. Four species of salamanders new to the State of California, with a description of *Plethodon elongatus*, a new species, and notes on other salamanders. Proc. Calif. Acad. Sci., Ser. 4, 6(7): 215–221.

WHIPPLE, I. L.

1906. The naso-labial groove of lungless salamanders. Biol. Bull., 11: 1–26.

WOOD, W. F.

1940. A new race of salamander, *Ensatina eschscholtzii picta*, from northern California and southern Oregon. Univ. Calif. Publ. Zoöl., 42(10): 425–428.

YARROW, H. C.

1883. Checklist of North American Reptilia and Batrachia, with catalogue of specimens in U. S. National Museum. Bull. U. S. Nat. Mus., 24: 1–249.

PLATES

PLATES 11 AND 12

Variation in pigmentation in *Ensatina eschscholtzii* showing the diversity in color and pattern. The terminal races of the rassenkreis, *eschscholtzii* (1) and *klauberi* (20), which coexist in some parts of southern California, are shown on the extreme left and right. Other subspecies and intergrading populations are illustrated in geographic sequence between them. They are, left to right, *xanthoptica* (2), *oregonensis* (3), *picta* (4), *oregonensis-platensis* intergrade (5), *platensis* (16), *platensis-croceator* intergrade (17), *croceator* (18), *croceator-klauberi* intergrade (19). The ventral aspects of some individuals are shown below the dorsal views.

Illustrations of eye color and juveniles are arranged directly below those of the races or intergrading populations to which they belong, with the exception of (14), a young *oregonensis*.

Differences in size are not shown. Illustrations were prepared as live representatives became available. Most of them were completed before statistical study revealed size variation. Actually *picta* (4) is only about two-thirds the size of *eschscholtzii* (1) with *oregonensis* (3) intermediate. The remaining races are similar to *eschscholtzii*.

The identity of specimens and localities of collection are as follows:

1. *Eschscholtzii*, ad. ♀, Madelia Canyon, Sherman Oaks, Santa Monica Mountains, Los Angeles Co., Calif.
2. *Xanthoptica*, ad. ♀, Redwood Regional Park, Oakland, Alameda Co., Calif.
3. *Oregonensis*, ad. ♂, ½ mi. S Paradise Lake, King County, Wash.
4. *Picta*, ad. ♀, 3 mi. N Klamath, Del Norte Co., Calif.
5. *Oregonensis-platensis* intergrade, ad. ♀, 23.5 mi. N junction U. S. 299 and 99 on U. S. 99, Shasta Co., Calif.

6–10. Ventral views of foregoing animals.

11. *Eschscholtzii*, ad. ♂, same locality as 1.
12. *Xanthoptica*, ad. ♂, Berkeley, Alameda Co., Calif.
13. *Oregonensis*, ad. ♂, same individual as 3.
14. Juvenal *oregonensis*, 23 mm. in snout-vent length, from Portland, Multnomah Co., Oregon.
15. Juvenal intergrade between *oregonensis* and *platensis*, 20 mm. in snout-vent length, from same locality as 5.
16. *Platensis*, ad. ♀, 100 yds. SW Indian Caves, Yosemite Valley, Mariposa Co., Calif.
17. *Platensis-croceator* intergrade, ad. ♂, Kern County Park, 11 mi. NW Kernville, Kern Co., Calif.
18. *Croceator*, ad. ♀, 1 mi. SW Fort Tejon, Kern Co., Calif.
19. *Croceator-klauberi* intergrade, ad. ♀, Crystal Creek, N side San Bernardino Mountains, W Cushenbury Springs, San Bernardino Co., Calif.
20. *Klauberi*, ad. ♀, near Julian, San Diego Co., Calif.

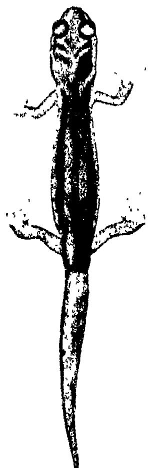
21, 23, 25. Ventral views, respectively, of *platensis*, *croceator*, and *klauberi*.

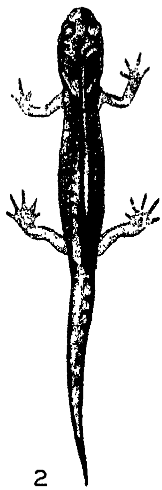
22. Juvenal *platensis-croceator* intergrade, 26 mm. in snout-vent length, from same locality as 17.

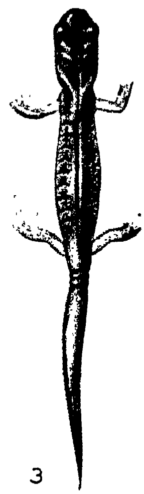
24. Juvenal intergrade between *croceator* and *klauberi*, 28 mm., from same locality as 19.

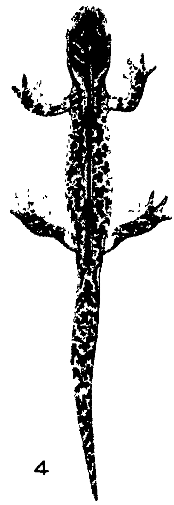
26, 28, 30. Juvenal *platensis*, *croceator*, and *klauberi*, measuring, respectively, in snout-vent length, 30, 37, and 28 mm.

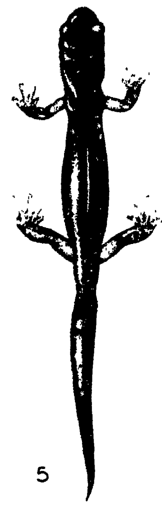
27, 29. Dorsal and ventral views of *xanthoptica-platensis* hybrid from Jawbone Ridge, Tuolumne Co., Calif.

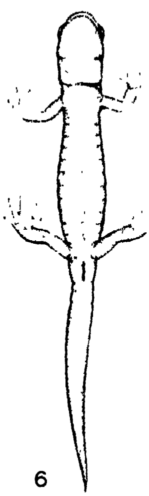

1

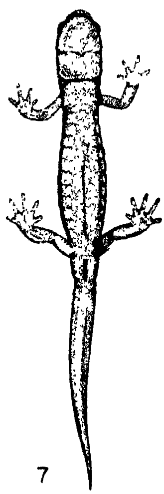

2

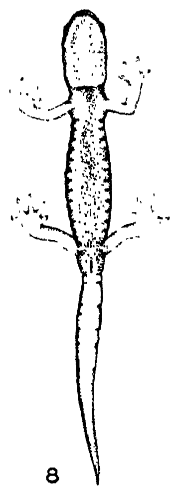

3

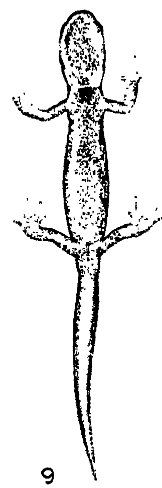

4

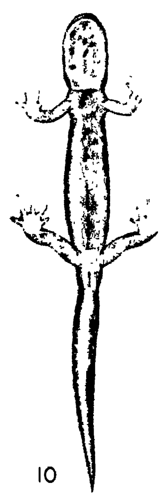

5


6


7


8


9


10


11


12


13


14

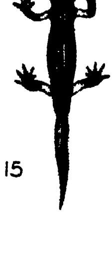

15

PLATE 12

See explanation of plate 11.

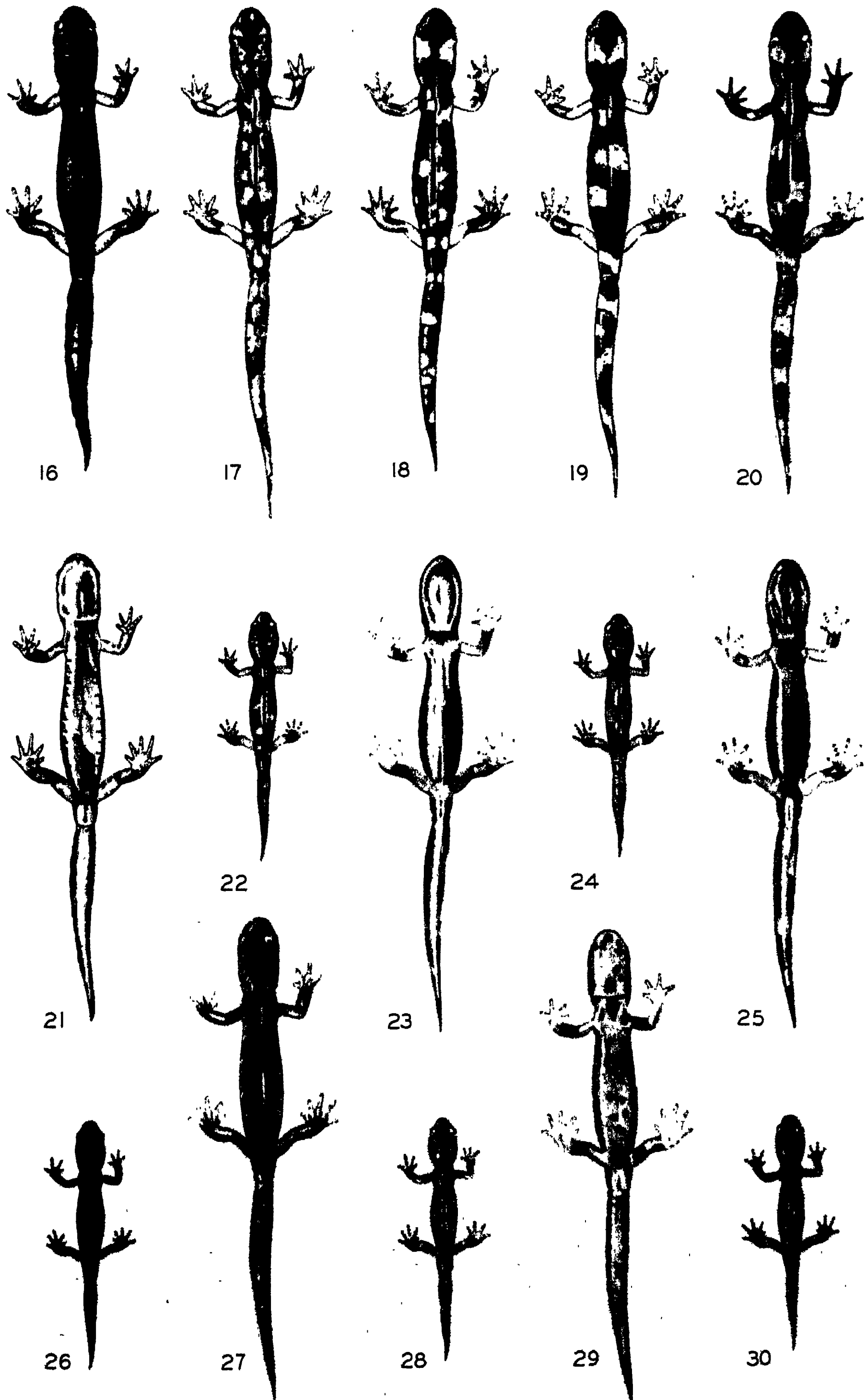

16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

PLATE 13

Variation in dorsal spotting in Ensatina. Individuals are arranged roughly in sequence from north to south, as they occur in the interior mountain ranges of California. Note that blotches tend to increase in size and regularity of outline. There is also a tendency toward formation of a U-shaped band on the head.

Specimens upon which drawings are based and localities of collection are as follows: Type 1, without spotting, is not shown.

2. SNHM 1807, Fyffe, El Dorado Co.
3. SNHM 3664, Crescent Meadows, Sequoia Nat'l Park, Tulare Co.
4. MVZ 41228, Mineral, Tehama Co.
5. MVZ 33953, Quaking Aspen Meadow, Tulare Co.
6. SNHM 1609, White River, Tulare Co.
7. MVZ 21912, Lake Sequoia, Fresno Co.
8. CAS 63806, Sequoia Nat'l Park, Tulare Co.
9. MVZ 41792, Kern Co. Park, 11 mi. NW Kernville, Kern Co.
10. MVZ 41799, Fort Tejon, Kern Co.
11. MVZ 41798, Fort Tejon, Kern Co.
12. TS 3190, Crystal Creek, San Bernardino Co.
13. USNM 75230, Mill Canyon above Banning, San Bernardino Co.
14. USNM 75229, Mill Canyon above Banning, San Bernardino Co.
15. LMK 1175, Julian, San Diego Co.
16. LMK 9516, Pine Hills, San Diego Co.
17. LMK 9515, Pine Hills, San Diego Co.
18. LMK 1174, Julian, San Diego Co.
19. SSNH 16548, Pine Hills, San Diego Co.

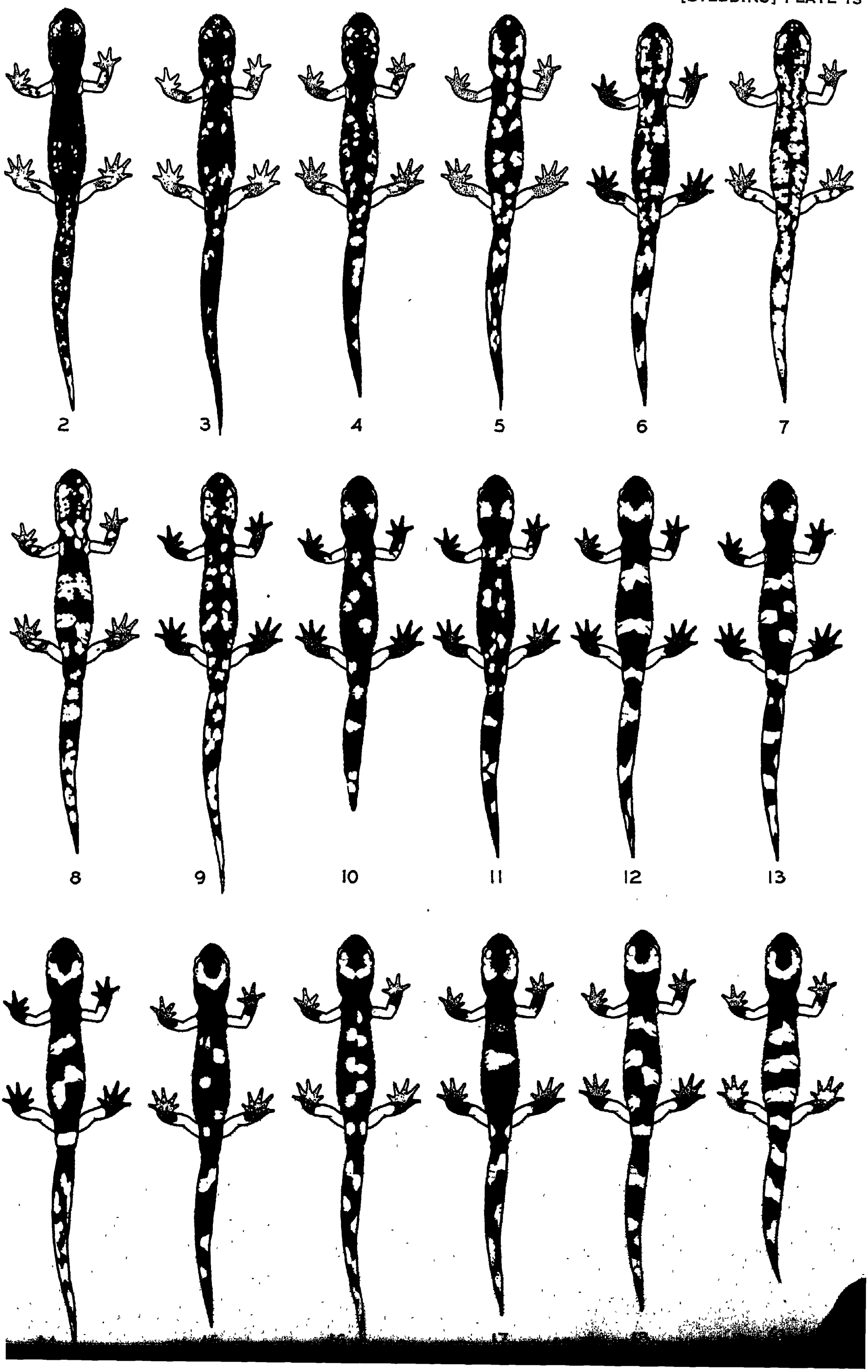

2
3
4
5
6
7
8
9
10
11
12
13

PLATE 14

Fig. 1. Dorsal view of the type specimen of *Urotropis* (=*Ensatina*) *platensis* Espada. Dorsal light blotches as shown in Espada's original figure have faded (see Dunn, 1926, for a reproduction of this illustration). Photograph through the courtesy of Dr. Ernesto Cusi of the Instituto José de Acosta, Museo Nacional de Ciencias Naturales, Madrid, Spain.

Fig. 2. Dorsal views of the "type" specimens of *Ensatina eschscholtzii.* The pigmentation of these individuals confirms Boulenger's reference to the type locality as "Monterey, California." Photograph provided through the courtesy of H. W. Parker of the British Museum of Natural History.

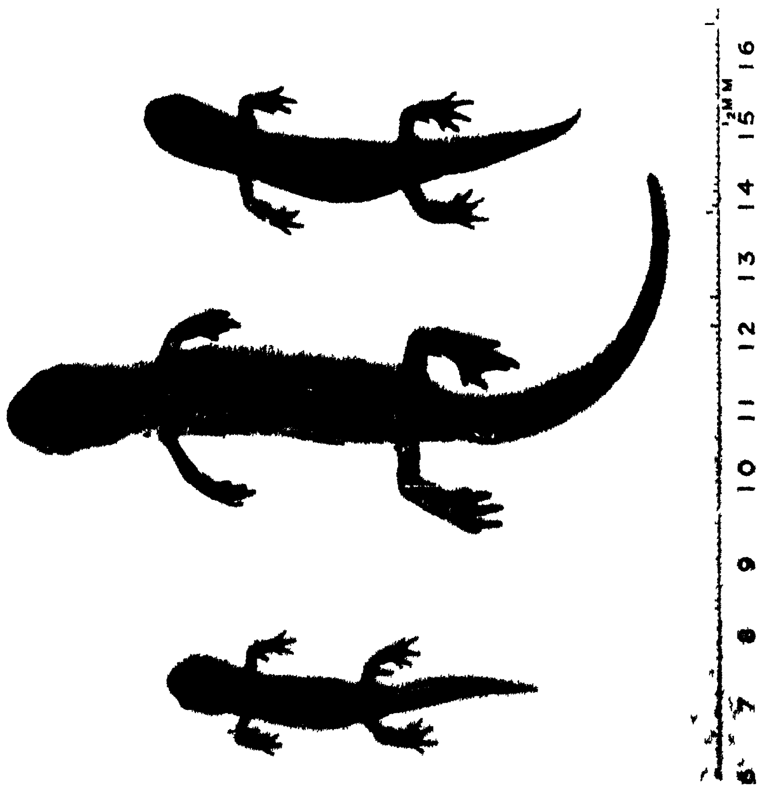
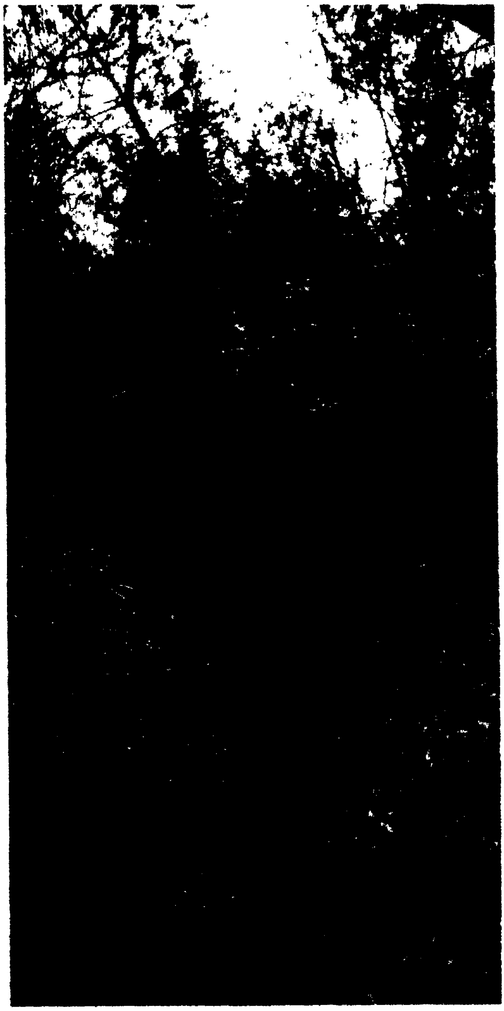


Fig 1 (above), fig 2 (below).

PLATE 16

Habitat of *Ensatina e. eschscholtzii* in Madelia Canyon, Sherman Oaks, Santa Monica Mountains, Los Angeles County, California. The canyon is canopied by wild black walnuts and coast live oaks. A heavy growth of grass, miner's lettuce, and *Nemophila*, covers the ground. Salamanders were found under pieces of shale, logs, bark, and leaf litter in the bottom of the ravine.



INDEX